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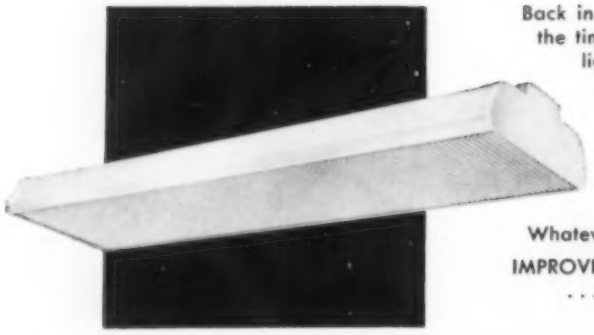

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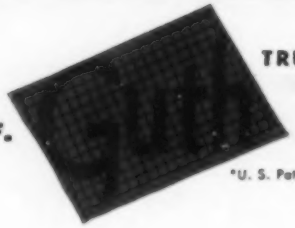

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July
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Many people within and outside the lighting industry have inquired about the progress of high frequency fluorescent lighting. It is the purpose of this article to outline some of the important characteristics of the component parts as an aid to proper engineering appraisal of the system.

Elements of
High Frequency Fluorescent Lighting

By J. H. CAMPBELL

In the past few years, the operation of fluorescent lamps on frequencies higher than 60 cycles has been widely discussed. Installations of high frequency lighting now in use include applications in plant growth areas, university field houses, office buildings and industrial areas. The success of these installations has served to further stimulate the interest of most branches of the lighting industry and their many consumers.

Following are the questions most often asked about high frequency fluorescent lighting:

- **What are the objectives of research and development in the field of high frequency lighting?**
- **Are there any improvements in lamp operation?**
- **Are special lamps required?**
- **Does higher frequency operation result in circuit and ballast improvements?**
- **What frequency is best for fluorescent lighting?**
- **How is 60-cycle changed to a higher frequency?**
- **What is the optimum voltage for distribution?**
- **Split phase or all capacitor ballasts?**

History and Objectives

High frequency lighting evolved through a long series of experiments on the lamps, ballast circuits, frequency converters and distribution systems. Much of this effort was made at a time in the development of fluorescent lamp circuits when it became evident that improvements in the size, weight and cost of ballasts would reach the point of diminishing returns on 60-cycle power. Frequency converters have been designed to supply power to fluorescent lamp loads at 360, 400 and 840 cycles. Although advantages in lamp operation can be shown for frequencies much higher, economics of converter design and corresponding distribution costs have dictated the upper frequency limit.

The distribution of power at frequencies greater than 60 cycles is certainly not new although we seldom give thought to the reasons why the industry arrived at the presently accepted level. A brief research on the subject revealed the following:

From 1886 to 1890, a common frequency for distribution was 133 cycles. This resulted from early design alternators having eight poles and rotating at 2000 r.p.m. The main advantage appeared to be smaller distribution transformers than would be possible at lower frequencies. At this period in the industry it was determined that a-c power could not be expanded economically with belt-driven generators. Since the prime movers of the time would not develop the speed required for direct drive, lower frequencies won early support and 25-cycle operation dominated the field until after the turn of the century. With the introduction of the turbogenerator, operation turned again to higher frequencies and by 1910, 60-cycle power, an admitted compromise, was leading the field and later won general acceptance as the standard.

Although it would not be feasible or economical to change the frequency for general power distribution, it can be changed to the advantage of the user at the load point.

AUTHOR: General Electric Company, Large Lamp Department, Advance Engineering, Nela Park, Cleveland, Ohio.

Now let us analyze some of the reasons for considering high frequency power for fluorescent lighting. All electric discharge light sources require control equipment to supply the proper voltage and limit the current to specified ratings. Considerable progress has been made in improved 60-cycle ballast designs. Typical of the success of this development is the progress made in ballasts for the 96-inch T-12 slimline lamp. Today's series ballast for two of these lamps weighs only 9½ pounds and consumes only 30 watts. A few years ago, the only ballast available weighed 21 pounds and consumed 45 watts.

While improvements such as these were being made, lamp developments showed a trend toward higher lamp current and greater lumen output, thus increasing the unit weight, size and cost of the individual 60-cycle ballasts. The continuing trend toward higher lighting levels and increased loads in almost all applications points up the need for further evaluation of the advantages of high frequency operation and an independent centrally located power supply for fluorescent lamps.

Research and development work on this project was started in 1941, but was interrupted during the war years, then resumed in 1946[1] and has been conducted concurrently with 60-cycle circuit development ever since.

The high frequency system development includes the following divisions of research, experimental design and test work:

1. Lamp characteristics over a wide range of frequencies.
2. Lamp ballast circuits.
3. Converters designed for fluorescent lamp loads.
4. Distribution of power.
5. Applications.

The scope of this article does not permit a comprehensive account of each division of the research and development work. However, anyone interested in further details may obtain them by checking the list of references.

Lamp Characteristics

Any standard fluorescent lamp may be operated at frequencies higher than 60 cycles and, in most cases, with improved operating characteristics. Lamp characteristics and the choice of ballast circuits depend to some extent on the current waveform delivered to the lamp. The two types of frequency converters now in use have considerably different characteristics, the rotary supplying a sine wave of voltage provides a sine wave of current, while the presently available magnetic frequency multiplier supplies a triangular voltage wave and with a capacitor ballast, a square wave of current. Fig. 1 illustrates two high frequency ballast circuits now in use and the corresponding voltage and current waveforms delivered to the lamp by the two types of converters to be discussed later.

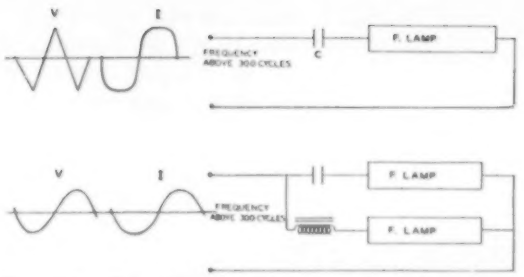

Figure 1. Top diagram illustrates triangular voltage waveform produced by 360-cycle magnetic frequency multiplier. Square wave lamp current results when capacitor ballast is used. Lower diagram shows sine wave of current and voltage supplied by rotary frequency converters. Lamp current is a sine wave whether capacitor or choke ballast is employed.

Fig. 2 illustrates the increase in lamp efficiency for three types of fluorescent lamps as frequency is raised. Lamps were maintained at their 60-cycle rated wattage level over the entire frequency range. Various lengths of standard lamps are used to illustrate differences in efficiency with increase in length. The shorter lamps of the same diameter have the greater over-all efficiency increase for any given frequency compared to 60 cycles because the losses at the electrodes are constant regardless of

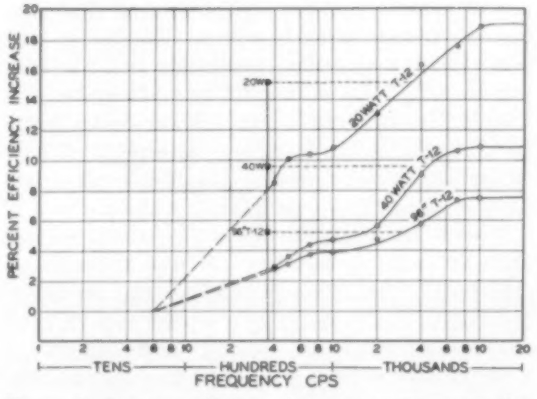

Figure 2. Per cent efficiency increase vs frequency for 24-inch, 48-inch and 96-inch lamps of T12 diameter. Lamps were held at their 60-cycle rated watts over entire frequency range. Points on the 360-cycle line show per cent increase in efficiency when lamps are operated on a square current wave.

length, and in the shorter lamps these losses represent a larger percentage of lamp watts. It is the reduction of electrode losses as frequency increases which is largely responsible for the efficiency increase.[2] Lamps operating at 60 cycles will have cathode drops of 10 to 15 volts, anode drops of 3 to 6 volts and electrode filament drops of 2 to 3 volts. If all of the end losses of a 40-watt lamp were eliminated, the increase in lamp efficiency would be approximately 20 per cent.

The vertical line with additional points illustrates the greater increase in lamp efficiency at 360 cycles when lamps are supplied with a square current waveform. This is the rated frequency of presently available magnetic frequency multipliers. Other points on the three curves are efficiency figures representing the average of lamps ballasted by means of a series inductance and a series capacitor with a sine wave of voltage and current supplied by rotary frequency converters.

While the increase in lamp efficiency with frequency is significant, this advantage must be combined with several others to justify frequency conversion. It had been found in comparative tests on sine wave operation that lamps operated at 400 cycles can be loaded to greater wattage without sacrifice of lamp life, thus making practical the increased light output of luminaires. Results of field tests seem to bear out this observation, but many more time consuming tests such as those now in progress must be made before official life ratings can be attached to lamps of various sizes operating at higher loadings with various circuits and waveforms.

The chart of Fig. 3 shows the lumen increase in percentage of the maximum 60-cycle rating when 96-inch T-12 and 48-inch T-12 lamps are operated at higher currents densities and greater wattage with 400- and 840-cycle sine wave and 360-cycle square wave supplies.

If the same lamps are operated on 60 cycles at correspondingly higher loading, the lumen output will also increase, but at a somewhat lesser amount due to lower lamp efficiency.

With respect to the design of luminaires, one of the important advantages of high frequency operation is the increase in light output at higher loading made more attractive by reduced ballast size, weight and loss. For example, a 96-inch T-12 slimline lamp operating at 425 ma on the smallest two-lamp 60-cycle ballast provides 1260 lumens per pound of ballast. The same lamps operated at 600 ma on a two-lamp 400-cycle ballast produce 3430 lumens per pound of ballast.

Although the weight of the frequency changer

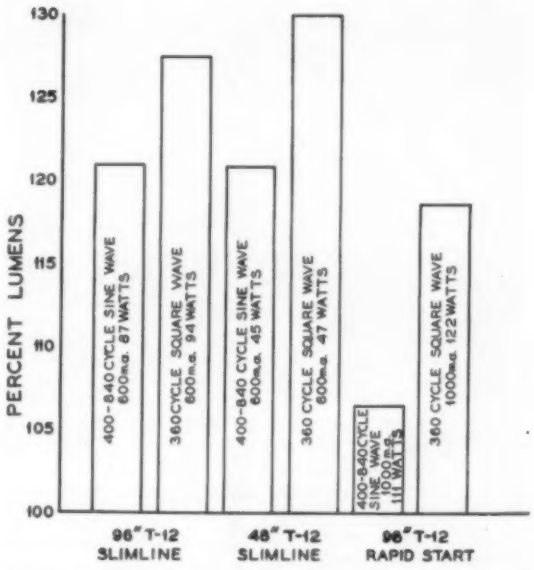

Figure 3. Light output of luminaires can be increased with lamps loaded to higher wattage at any frequency. However, increases in lumens above present maximum 60-cycle rating shown in the chart can be accomplished at 360, 400 and 840 cycles with greatly reduced ballast size, weight and loss.

need not be considered a luminaire design, it should be accounted for economically as a remoted section of the ballast. The overall system lumens per pound then becomes 1430 with a 400-cycle rotary frequency changer of 50 kw capacity.

Ballast Circuits

Current limiting devices for fluorescent lamps can be listed as follows: inductive reactance, capacitive reactance and resistance. Ballasts for the low frequencies of 60, 50, and 25 cycles generally consist of combinations of inductive and capacitive reactance in series relationship with the lamp load. Resistance in the form of a tungsten filament lamp or nichrome wire has been employed as a ballast for small lamps on d-c and for special applications on alternating current where weight or space limitations are factors. The relatively high loss of resistance ballasting is the main deterrent to its general application. It has been established in previous papers and articles that a series capacitor is not practical as a ballast for 60-cycle operation of present fluorescent lamps, because of the highly commutated and peaked lamp current waveform. However, at frequencies of 300 cycles and above, a reasonably good current waveform permits the use of this advantageous ballast.[1] Capacitor ballasts provide a current limiting device of very light weight, low loss and small size. Inductive reactors

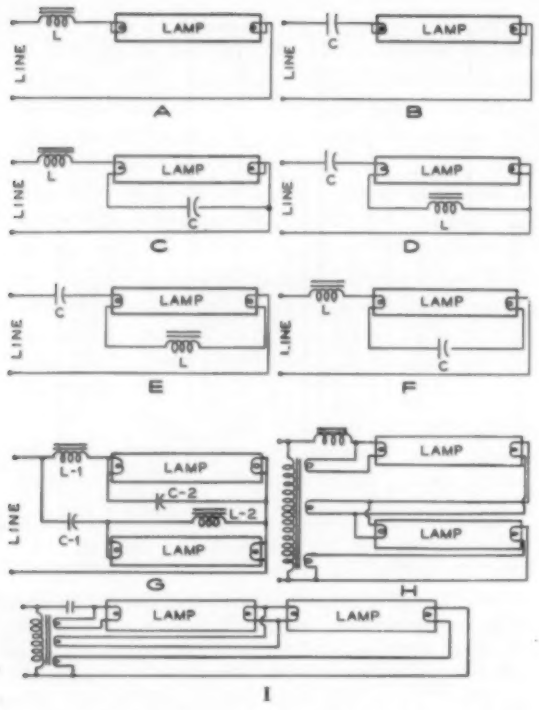

Figure 4. Ballast circuits for use with fluorescent lamps at power frequencies above 300 cycles.

are considerably smaller than their 60-cycle counterparts for frequencies of 400 cycles and above, the size and loss being somewhat dependent upon the choice of iron and the flux density.

Some of the many circuits designed to operate fluorescent lamps at high frequencies are shown schematically in Fig. 4. The series inductance of 4A and the series capacitor of 4B are commonly used because of their simplicity, small size, and low loss. In most applications to date, the starting voltage is distributed directly from the generator to the load, thus making it unnecessary to use transformers at the ballast. The finished ballast includes both elements making a split phase circuit to operate two lamps at nearly unity power factor. In some installations it is desirable to use capacitor ballasts exclusively with power factor correction obtained through a lumped inductance at the generator or at each branch circuit as economics dictate. Circuits C and D show possible designs in which voltage to start is obtained by resonance to allow the distribution of a lower line voltage while still making it unnecessary to apply a step-up transformer. Circuits E and F provide the increase in voltage by resonance, but are connected to preheat the electrodes during the starting period. A two-lamp split phase resonant circuit (G) could be employed for lower voltage distribution such as 120, 240 and 277 volts.

For best over-all economy in the distribution system and the ballast, high frequency systems have been designed to distribute either 400 volts or 600 volts, the choice depending upon the starting voltage of the lamps to be used. Since the cost of wiring decreases with increased voltage, it appears advisable to use the maximum permissible voltage of 600 volts line to line (300 volts to ground). This voltage also permits starting of any length of slimline lamp, rapid start or power groove of T-12 or T-17 diameter. The two-in-series lag and two-in-series lead circuits for 96-inch T-12 high current rapid start and 96-inch power groove TG-17 lamps are shown in Figs. 4H and 4I. In each of these circuits a small transformer is utilized to supply preheat voltage to the lamp electrodes. Lead and lag circuits can be combined to provide a load power factor of approximately 96 per cent.

The photograph of Fig. 5A shows the size comparison of a two-lamp 96-inch T-12, 60-cycle slimline ballast (background) which delivers 74 watts at 425 milliamperes per lamp with a two-lamp 96-inch T-12, 400-cycle ballast (foreground) delivering 90 watts at 600 milliamperes per lamp. Fig. 5B shows a similar 60-cycle ballast with two capacitor ballasts (foreground) which perform the same function at 400 cycles. The latter combination has a leading power factor of approximately 30 per cent and would require a lumped inductance in the branch circuits or at the generator to increase load power factor to an economical level.

Ballasts

Ballast types designed for frequencies of 360, 400 and 840 cycles range in weight from one-third of a pound for a single 40-watt lamp to nine pounds for two power groove lamps. The range for equivalent 60-cycle ballasts is 1½ pounds to 26 pounds.

The small, lighter weight high frequency ballasts provide the basis for the developing trend toward a centralized power system in which the bulk of the ballast weight and heat loss is removed from the fixture and placed in a central location such as a transformer vault or blower room.

Frequency

The question as to what frequency is best for operation of fluorescent lamps may not be completely resolved for some time. It has been shown by a series of comprehensive lamp[3] and circuit tests that lamps increase in efficiency as frequency is increased to a level of approximately 10,000 cycles. However, the greatest reduction in ballast

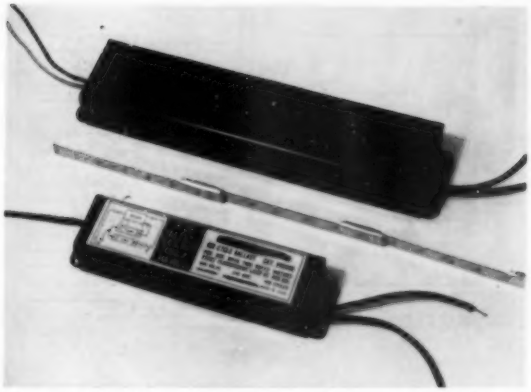

Figure 5A. Size comparison: Background — 2-lamp 96-inch T12 60-cycle 425 ma slimline ballast. In the foreground — 2-lamp 96-inch T12 400-cycle 600 ma slimline ballast.

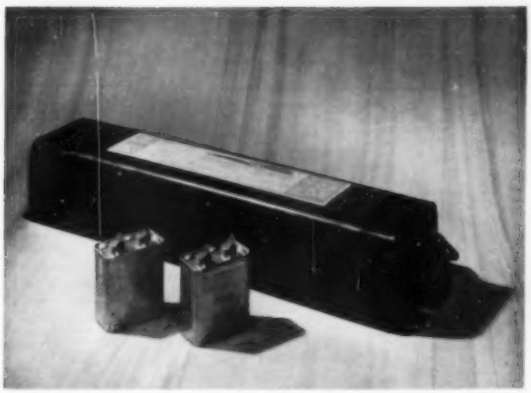

Figure 5B. Size comparison: Background — 2-lamp 96-inch T12 60-cycle 425 ma slimline ballast. Foreground — two single 96-inch T12 400-cycle 600 ma slimline capacitor ballasts.

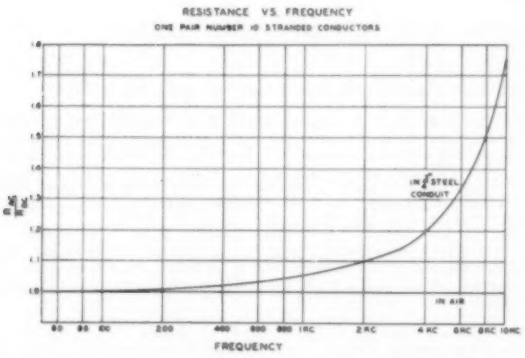

Figure 6. Ratio a-c to d-c resistance vs frequency.

size and weight takes place around 300 cycles at which point capacitor ballasts become practical. If 96-inch T-12 lamps are ballasted exclusively by means of capacitors at 400 cycles, ballast weight at the fixture is reduced by 92 per cent compared to the smallest 96-inch T-12 60-cycle ballast. At 3000 cycles, the reduction in weight would be approximately 96 per cent. Obviously, this gain at any frequency does not apply to the entire system because of the converter and power factor correction elements. The choice of frequency therefore depends upon the over-all economics of the system, including converter, panel, switches, wiring and ballasts. It is the author's opinion that the question of frequency distribution can best be resolved by the apparatus and component manufacturers of the electrical industry, perhaps through an industry committee sponsored by one of the technical societies.

Branch circuit wiring at frequencies in the range of 400 to 1000 cycles will result in a derating over 60 cycles of only one per cent to six per cent where branch circuits do not carry over 20 amperes. Fig. 6 shows the ratio of a-c to d-c resistance for a pair of No. 10 stranded conductors in ¾-inch conduit in which frequency was varied over a range of 60 to 10,000 cycles.

Converters

At the present time there are two types of frequency converters designed to operate fluorescent lamps:

1. Magnetic frequency multiplier (360 cycles).
2. Rotating frequency converter (motor generator sets, 400 cycles or higher).

The magnetic frequency multiplier[4] has the advantage of no moving parts and can be installed in the same way as a transformer. A control on the panel makes it possible to regulate the current to the lamp load for maximum flexibility. This power supply provides a triangular voltage wave and lamps operate on a square current waveform with individual capacitors as ballasts (Figs. 1 and 2). A number of special applications of this system have been made, but to date the unit is available in a 5-kw size only and a relatively high cost per kw has prevented its use in general lighting.

Distribution of Power

Rotary frequency converters[5, 6] are comparatively low in cost and very little preventive maintenance is required to keep the equipment in operation for many years. Generators of 25-, 50- and 100-kw sizes have been designed to the requirements of fluorescent lighting loads. The schematic diagram of Fig. 7A shows the generator connected to the ballast and lamp load. The connection of generator coils consists of a double delta winding

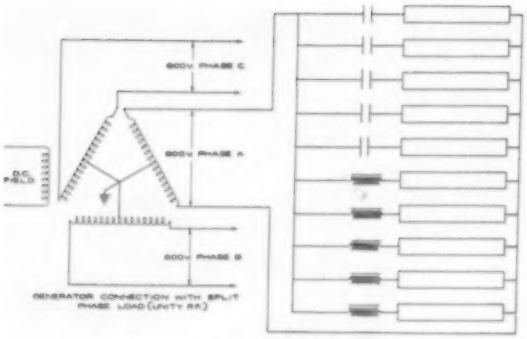

Figure 7A.

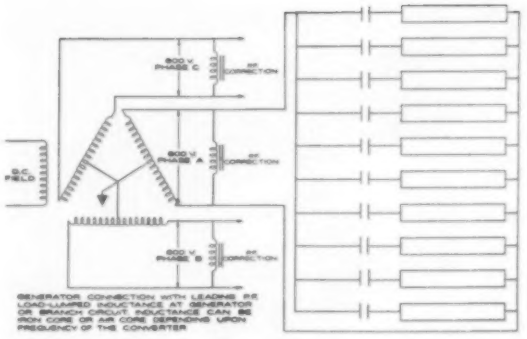
600 V. PHASE C
PF. CORRECTION
600 V. PHASE A
PF. CORRECTION
600 V. PHASE B
PF. CORRECTION
D.C. FIELD
GENERATOR CONNECTION WITH LEADING PF. LOAD-LUMPED INDUCTANCE AT GENERATOR OR BRANCH CIRCUIT INDUCTANCE CAN BE IRON CORE OR AIR CORE DEPENDING UPON FREQUENCY OF THE CONVERTER

Figure 7B.

with all three mid-taps brought out to a common ground. With this arrangement, individual phases are connected as three single phase circuits. The National Electric Code permits 600 volts line to line and 300 volts line to ground. Present General Electric 400-cycle power supplies are equipped with automatic regulators for the field supply and the output of each pair of lines is rated at 575 volts and 287 volts to ground. The load in Fig. 7A consists of alternate inductive reactor and capacitor ballasts for unity power factor. Fig. 7B shows exclusive use of capacitor ballasts with lumped inductance at each branch circuit to correct power factor. This load arrangement is used with the present magnetic frequency multiplier and power factor correction is obtained within the power supply. If applied to rotary frequency converters, separate reactors must be designed and applied to branch lighting circuits or to the generator. Here again the point at which connection is made will depend upon the combined cost of capacitors and power factor correction reactors *vs* the cost of split phase unity power factor ballasts. To date, it appears that over-all cost is less with split phase ballasts at 400 cycles (Fig. 7A). At higher frequencies such as 840 cycles, the ballast cost may be lower where all capacitor ballasts are used and power factor correction is made with air core reactors.

It is quite possible that rotary frequency converters can be designed to generate a triangular voltage waveform to provide lamps with the advantageous square current. However, the waveform must be retained over varying load conditions in order to maintain the rotary's present advantage of flexibility in branch circuit switching.

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Applications of

High Frequency Fluorescent Lighting

By Q. D. DOBRAS

THERE HAS been a great deal of interest in the operation of fluorescent lamps at higher frequencies. Research conducted over the last several years has shown that lamps and ballasts will operate more efficiently as the applied frequency increases. In order to take advantage of the many benefits of high frequency lighting, applications had to wait on the development of frequency converters, ballasts and circuits. These components are now combined in a high frequency lighting system which may be used advantageously in a variety of applications.

Considerable progress has been made toward a practical high frequency lighting system. The recent development of circuits and ballasts for high output rapid start and power-groove lamps was a major step to broaden the field for high frequency lighting. Now this system of operation can be applied to many areas previously considered impractical and uneconomical.

Some of the advantages of high frequency can best be described by reviewing some of the pioneering installations where high frequency lighting is already in operation.

Higher Footcandle Installations

One of the problems in providing higher footcandle levels is to obtain the maximum amount of light while minimizing heat losses. Radiant energy from incandescent lamps becomes objectionable in lighting levels above 50 footcandles. With the more efficient fluorescent lamps, radiant heating from lamps and ballasts becomes a factor above 200 footcandles. High frequency operation offers a means of providing higher footcandle levels with ballast heat losses considerably reduced.

The reduction of heat from fluorescent lamp ballasts was the problem at the Plant Industry station of the U. S. Department of Agriculture in Beltsville, Maryland, where the first installation of high frequency lighting was made. Plant physiologists at this laboratory are experimenting with plant growth using artificial light on a carefully planned exposure schedule. For this application it was necessary to supply high level fluorescent lighting evenly distributed over the plant growth area. To accomplish this, 96T8 slimline lamps were installed

Figure 1. First installation of high frequency lighting, at the Plant Industry Station, Beltsville, Maryland.

Figure 2. Remotely located ballasts were required for the Beltsville installation.

AUTHOR: General Electric Co., Nela Park, Cleveland, Ohio.

Figure 3. Note difference in ballast size for 60 cycles (right) and for 360 cycles.

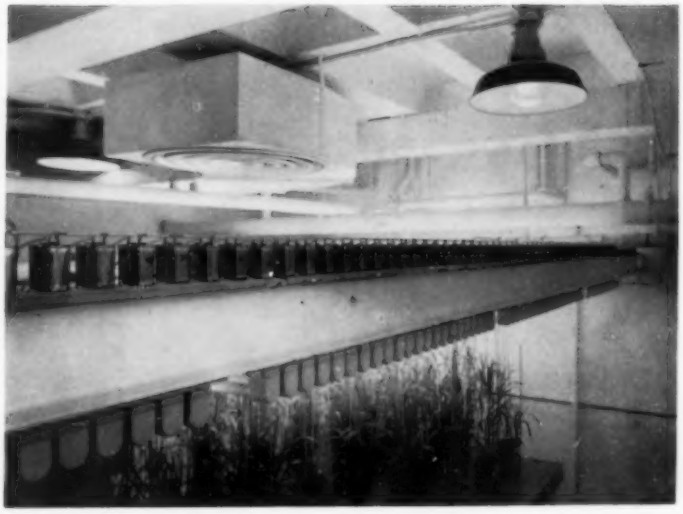

Figure 4. One section of the Beltsville room using 360-cps distribution. By using this system it was possible to locate the small capacitor ballasts directly over each lamp; thus only two wires were needed to bring power to the lamps.

Figure 5. Using a high frequency system, this electronic assembly plant is provided with 450 footcandles for precision seeing.

Figure 6. An experimental high frequency installation now under study. Over 1000 footcandles are provided. Power is supplied from a generator rated at 400 cycles and 600 volts center tapped to ground. Savings in lighting load run 12 per cent.

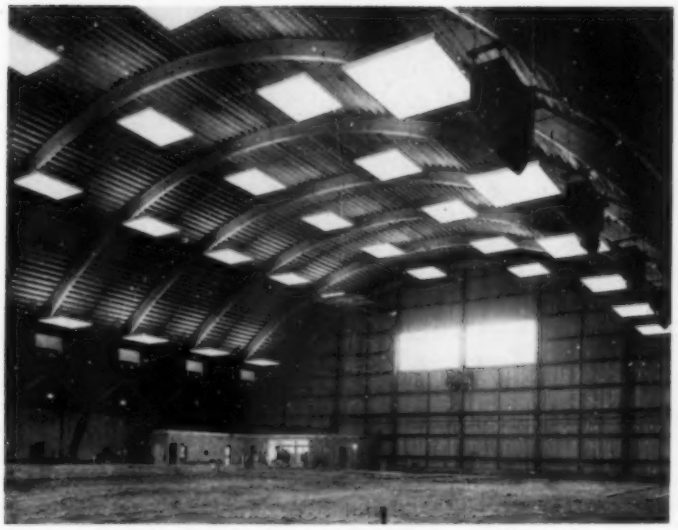

Figure 7. The first high mounting large-scale installation was in this field house at Union College, Schenectady.

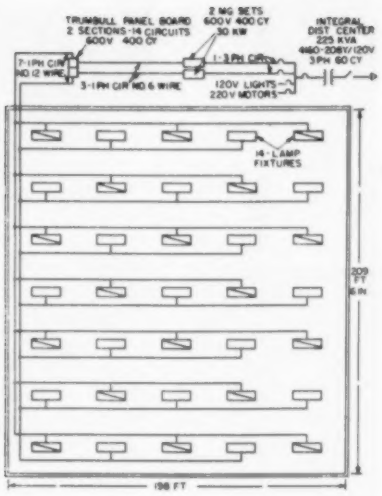

Figure 8. Wiring line diagram for the Union College installation.

on two-inch centers. In the first rooms, using 60 cycles, it was necessary to locate the ballasts outside the room because of space limitations and to eliminate the long-wave infrared radiation resulting from ballast losses. Fig. 1 shows the plant growth area lighted in this manner. Fig. 2 shows the remotely located ballasts for this area. In order to bring power to the lamp load it was necessary to use a cable containing one common and one wire for each lamp. For one room the cable consisted of 89 conductors as shown in Fig. 3. In order to keep the size and weight of the ballasts reduced to a minimum, series capacitors were used. The comparison of ballast size for 60 cycles and 360 cycles is also shown in Fig. 3.

By using 360 cycles it was possible to locate the small capacitor ballasts directly over each lamp—thus only two wires were needed to bring power to the lamps. Fig. 4 shows a section of the room with 360-cps distribution.

Power was obtained from two 5-kw magnetic frequency multipliers located in a transformer vault. In addition to the advantages previously mentioned, a small output current control located on the multiplier is used to vary the light output from the lamps. The 360-cycle room had a range of 1600 to 2400 ft-c, where as the 60 cycle rooms had a fixed level of 1600 ft-c.

Since this first installation about 30 similar plant growth areas in laboratories, high schools, and universities across the country have installed 360-cycle lighting systems. It was the start of a new era in lighting not only for plant growth areas but for a variety of applications which could take advantage of the operating characteristics of high frequency lighting.

High frequency may, of course, be used to provide higher footcandle levels for other applications. Many installations of 200-500 footcandles in office and industrial areas are already in service. Lighting levels much higher may be justified but the problems of visual comfort and excessive heat must first be solved. The increased complexity of today's industrial tasks and the increasing use of high-speed automatic machinery indicates that such lighting levels will be much more common in the near future. The electronic assembly operation shown in Fig. 5 is performed under 450 footcandles. The increased quality of workmanship, it was felt, entirely justified the cost of this lighting in a very short time.

Further information on the technique and possible benefits of higher footcandle levels will be obtained from an experimental high frequency installation now being studied at Nela Park. This area, shown in Fig. 6, is 15 ft x 24 ft and is lighted by 54 96PG17 power-groove lamps. Over 1000 footcandles initially are provided. The power is supplied from a generator rated at 400 cycles and 600 volts center-tapped to ground. A saving of approximately 12 per cent in the lighting load was realized by the use of high frequency distribution. Due to the combination of well-designed aluminum reflectors and louvers and high frequency distribution the area is surprisingly comfortable both from the standpoint of brightness control and heat sensation. The data and experience derived from this installation should prove of aid to future applications.

Figure 9. Fourteen-lamp fixture prototype. Ballasts weigh just 120 lbs. A similar fixture for 60-cycle would weigh over 250 lbs.

High Mounting Installations

The first large installation using a 400 cps rotary converter was made in a new field house at Union College in Schenectady, New York. This installation in the Alumni Memorial Field House is shown in Fig. 7.

Since the ballasts for 400 cps are smaller and lighter, they lend themselves well to lighter weight fixtures with resulting economies. Fixture designs need not be hampered by the necessity for a large heavy channel or other heavy ballast supporting members. Large multiple lamp fixtures such as these become practical and economical.

Two 30-kw 400-cycle rotary converters supply power to 35 large multiple lamp fixtures. Each fixture contains 14 96T12 slimline lamps operated at 600 ma. Lamps are ballasted alternately with series chokes and capacitors to obtain unity power factor. Fig. 8 indicates the wiring line diagram. Each converter supplies power to alternate fixtures to permit uniform lighting with one or both generators in operation.

Since special apparatus must be used to convert to the desired frequency, the distribution voltage was chosen to suit the lighting requirements rather than a compromise to suit both power and lighting. A voltage of 600 volts is sufficient to start 96-inch instant start lamps without the need for step-up auto-transformers in each ballast. This higher voltage has a two-fold advantage: (1) Ballasts can be smaller and cheaper, and (2) the distribution system requires fewer branch circuits and is less expensive than lower voltage 60-cycle systems. Present rotary converters for high frequency lighting have three individual 600-volt phases with each center-tapped to ground to comply with the code requirement of a maximum of 300 volts to ground.

A total of 14 branch circuits carries the current to the 35 fluorescent lamp fixtures. This compared to 84 circuits for the originally proposed mercury-filament system.

The savings in weight was very important in this type of building construction. The fourteen lamp fixture prototype is shown in Fig. 9. This fixture prototype with ballasts weighs just 120 lbs. A similar fixture for 60 cycles would weigh over 250 lbs.

At Union College high frequency made practical and possible a fluorescent lighting system which supplied more light, at lower brightness, at greater comfort and at lower overall cost than a mercury-filament system commonly used for such areas. As a result of this installation other schools have reviewed the possibility of high frequency lighting in their field house construction and modernization programs. Installations are now under way in new field houses at University of New Mexico and at the Illinois State Teachers College.

A more recent installation of 400-cycle lighting was made at Convention Hall in Camden, New Jersey. Fig. 10 shows the Convention Hall which is lighted by 35 large fluorescent fixtures. Each fixture contains 16 96T12 slimline lamps; each is 4 ft wide and 16 ft long. The lamps are operated at

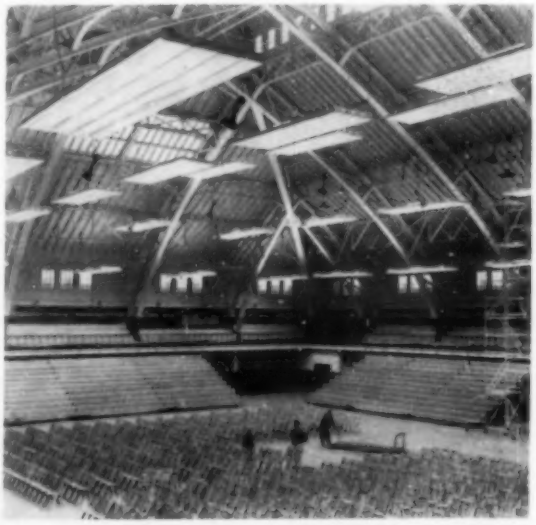

Figure 10. Recent 400-cycle installation at Convention Hall, Camden, N. J.; 70 footcandles maintained.

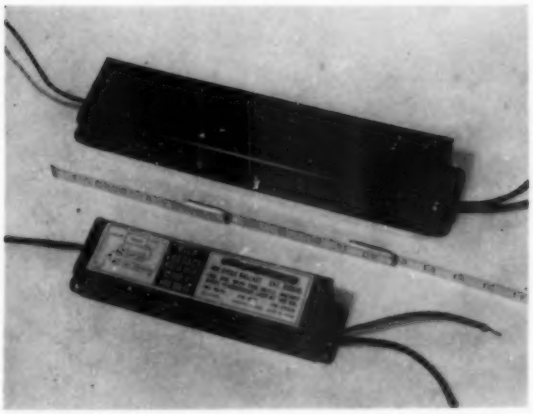

Figure 11. 400-cycle ballast at bottom has one-third the weight and half the watts loss of the 60-cycle.

Figure 12. Power is provided by the 50-kw 400-cycle motor generator set shown here.

600-ma which provides 6000 lumens per lamp and totals 96,000 lumens per fixture. Seventy footcandles are maintained in the entire area. Ballasting is provided by a new two-lamp lead-lag 400-cycle ballast. Fig. 11 compares the 400-cycle ballast to a conventional 60-cycle two-lamp series ballast. These ballasts have one-third the weight and half the watts loss of the 60-cycle ballast.

Power is provided by a 50-kw 400-cycle motor generator set shown in Fig. 12. The distribution voltage is 600 volts with 300 volts to ground.

The present lighting provides over twice the illumination at a 15 per cent savings in total annual costs over the previously installed incandescent lighting system.

Air Conditioned Offices

Application of high frequency lighting to office areas presents a considerably different picture from those of large areas. Advantages of large multilamp fixtures and long branch circuit runs cannot be so well utilized. However, an additional advantage is that of reduced heat losses at the fixture. The use of all capacitor ballasts can reduce the watts on the ceiling by about one kilowatt per 1000 square feet at a 100-ft-c lighting level. Split phase ballasts would have a reduction of about 750 watts per 1000 square feet. This can mean considerable saving in both initial and operating costs of air conditioning systems.

The first office building to use high frequency lighting was the Wakefield Company in Vermilion, Ohio. In this modern air conditioned building the use of high frequency lighting distribution, in this case 840-cps, resulted in a saving of 25 per cent in air conditioning capacity. By varying the size of the capacitor ballasts the current rating of the lamps could be adjusted which in turn varied the light output. By increasing the current rating of lamps in small offices, a uniform lighting level is obtained while keeping the lamp spacing constant above the luminous plastic ceiling. Certainly many office buildings can take advantage of high frequency lighting in future applications.

Industrial Lighting

It is in large industrial areas where high frequency lighting is expected to show its greatest advantages. Areas such as the large aircraft hangar in Fig. 13, or the heavy shop and assembly area in Fig. 14, can be lighted with high frequency fluorescent lighting at a lower cost than with any other fluorescent system. Full advantage can be taken of the lower cost 600-volt distribution system, economical multiple lamp fixtures and the larger more efficient frequency converters.

Additional cost advantages are found in the use of the higher output lamps such as the 800-ma rapid start and the 1.5a power-groove fluorescent lamps. The ballasting of the high current lamps is especially advantageous at high frequency. For example, the ballasts to operate four 8-ft power-groove lamps at 60 cycles consume about 160 watts and weigh over 50 lbs. At 400 cycles the ballasting for four lamps will weigh approximately 12 lbs and consume less than 50 watts. The advantage to industry of using high current lamps is evident when we consider that a fixture with four 96-inch power-groove lamps will have a greater light output than ten 96-inch slimline lamps such as were

Figure 13 (above) and 14 (right). Areas such as this large aircraft hangar, and heavy shop may be lighted with high frequency fluorescent lighting at lower cost.

used at Union College and Convention Hall.

Technological advances have placed high frequency lighting into the present as well as into the future. One of the more important developments is the design of circuits and ballasts to operate the high current lamps. In all phases of lighting the trend is toward higher lighting levels with increasing use of high wattage fluorescent lamps. Today the 96-inch power-groove lamp operates at 200 watts. The future may find fluorescent lamps operating at even higher wattages.

With the lamp wattage increasing, the problem of ballasting also increases. Ballasts must be larger, heavier and able to dissipate larger quantities of heat. At 360 cycles or more, ballast losses and weight are reduced. This in turn may simplify luminaire designs, and may make practical large multiple-lamp luminaires.

With its present operational advantages, high frequency fluorescent lighting may well become an important consideration in future installations for industry, offices, schools and stores.

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New one-story industrial office building of 5000 square feet used as pilot installation for high frequency fluorescent lighting.

Report on High Frequency Operation

By R. H. HORNER

This is a report upon the engineering phases, the installation, and the operation for more than a year of an electrical lighting system employing 840 cycles, 400 volts in a single-story office building completed in 1956.

The building is approximately 40 ft by 125 ft with an all-glass front. The rear wall and ends are of solid masonry. Electrical lighting is accomplished by 580 four-foot slimline lamps installed above four-foot acrylic plastic diffusers. In combination they constitute a luminous ceiling. The lighting load is 35-kw. The supporting grid carries sprinkler heads and perforated metal baffles which reduce noise and diffuse air. This modular grid receives the tops of office partitions.

Local 60 Cycles Converted to 840

About two years in advance, studies of frequencies up to 3000 were started. The decision was based upon the comparative economy of 840 cycles, as against higher frequencies, and the possibility of transmission difficulties if higher than 840. Economies entered also into the decision to use a motor generator 30-kva, M-G set as a converter. The static harmonic type would have been more expensive. The high maintenance cost of electronic types ruled them out in this case. The maintenance of rotating machinery includes some risk, but since the maintenance involves only the two bearings in the motor that drives the 400-volt generator, it becomes a routine check item familiar to all maintenance electricians. The motor operates at 440 volts 8-phase 60 cycles. It is of the permanent magnet type. Stator windings are fastened by a bell end. There is no voltage regulator or exciter. The over-all dimensions of the motor and the generator are 18 inches by 18 inches by 30 inches high.

The generator is designed toward creating a square current wave through the lamps. Actually some changes are needed to allow benefits of wave shape since, above 400 cycles, shape influences performance of lamps more than a rise in the frequency.

Distributing

The three phases are carried on a single phase system. All phases are center tapped and grounded for maintaining 300 volts or less to ground. The feeder wires are No. 6, type tw. Since the influence

Author: The Wakefield Company, Vermilion, Ohio.

Executive suite with multi-function ceiling utilizing 840-cycle lighting, providing 100 footcandles on desk top.

of the power factor on the generator was to be studied, resulting in higher line currents, the feeder wires are larger than usual. The switches are of the 600-volt, two-pole toggle type, controlling as many as 50 lamps.

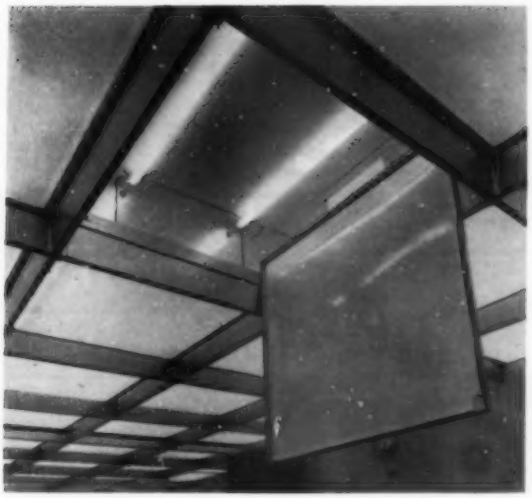
Circuits

Because fluorescent lamps have negative resistance qualities, the elements that limit the current are in series, and capacitors in series with the lamps are practical in this installation. They simplify lamp circuiting while reducing weight, noise, and heat. These capacitors also allow flexibility in the brightness of the lamps, increasing the light output in certain areas by as much as one-third.

To maintain uniform lamp spacing and near-uniform illumination in small and large offices and other areas there was a proportional increase in capacitance. Lighting levels in any specified area in the offices can be increased or lowered by replacing the capacitors with others of the right values.

There is a light-weight, low-cost capacitor for each of the four-foot lamps. Had eight-foot lamps been used, it would have been necessary to step up the voltage from 400 to 600 volts for quick starting. The leading power factor of the lamp and capacitor is 0.20. Correction is accomplished by an

General office lighted by high frequency lighting to 100 ft-c levels.



Maintenance feature of multi-function ceiling is illustrated to show access to plenum for relamping.

air core inductance across the line, with correction units mounted above the electrical channels and located to provide power factor correction ahead of the switch. Each power factor correction coil corrects 24 lamps to unity. For optimum operation of the generator the over-all power factor leads about 0.90.

Lamp Efficiency under High Frequency

In order to determine the efficiency of lamps under 840-cycle 400-volt operation, sixteen lamps and capacitors were hooked so that they could be powered by high-cycle and high voltage, or could be switched over to conventional ballasts and local 60-cycle 118-voltage operation. Under the higher frequencies and voltage they showed a 13 per cent increase in efficiency, including the loss in the M-G set which is 84 per cent efficient.

The high frequency and the wave shape produce close approximation to complete ionization throughout the cycle. Since the introduction of the fluorescent lamp about 20 years ago lamp engineers have recognized that a frequency far above the conventional 60 cycles is necessary to maintain a constant ionization field. In this operation the high frequency and the wave shape combine to produce almost complete ionization throughout the cycle. Thus far, the tendency of the ionization field to cushion the shock of the reversing arc appears to have lengthened cathode life. During about a year and a half of operation no lamps, capacitors, or switches have been replaced.

Air Conditioning Costs Cut

Though the ballast loss for an instant starting lamp is from 10 to 15 watts, the loss through the capacitors used in this installation is 1½ watts. The same amount is lost in the power factor correction coil. Theoretically, the use of capacitors instead of the usual ballasts would reduce the air conditioning load by two tons. Actually, a 20-ton unit has been satisfactory through an entire summer and winter instead of the 25-ton unit considered originally.

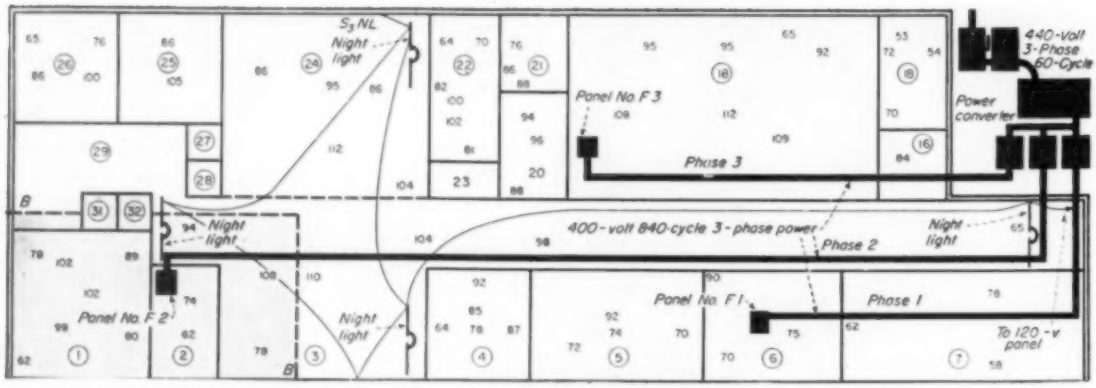
Initial and Operating Costs

When the plans of the office building were ready, electrical contractors were asked to submit two bids — one for installing a 118-volt 60-cycle system, the other at the higher voltage and frequency. Ruling out the cost of the generator and the lighting equipment, the difference of $1,840.00 was in favor of high frequency, which represented largely the saving in the simpler wiring.

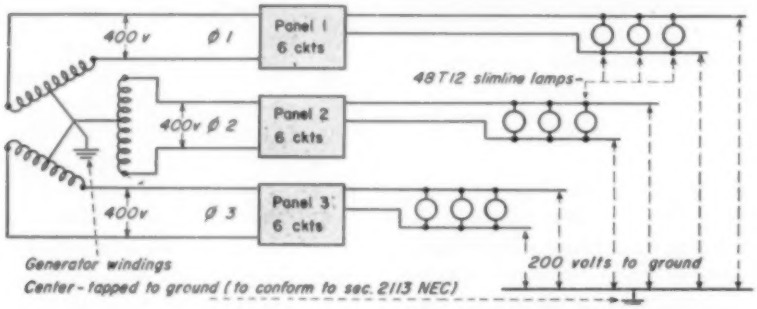
Because of greater lamp efficiency it was possible to use two lamps at high frequency to maintain a lighting level as high (90 footcandles) as three lamps would have produced. This saving in lamps and wiring, added to the saving in costs of capacitors compared with regular ballasts, and to the saving in air conditioning equipment, more than paid the cost of the power correction coils, and the high frequency generator.

As to operating costs, due to fewer lamps at higher efficiency and the greater flexibility, power

440-volt, 3-phase, 60-cycle motor left drives a 30-kva, 400-volt, 840-cycle, 3-phase, 6-wire permanent magnet generator, right.



Each phase is carried to a six-circuit fused distribution panel. Uncircled numbers show initial illumination at desk height.



Wiring arrangement for 840-cycle distribution. Each phase operates as a single phase system. Generator windings center tapped to ground.

consumption is about 20 per cent lower than with a conventional system, and there are less lamps to replace when group relamping is needed.

It seems reasonable to assume a reduction of 10 per cent to 15 per cent in costs of such a system elsewhere if the size of the operation lends itself to a higher frequency system and other conditions are favorable. Because it has been shown that electroluminescent panels rise in efficiency with an increase in frequency, it is likely that this type of lighting, when perfected, will be another reason for utilization of higher frequencies.

Register Now for the National Technical Conference

Registration blanks for the National Technical Conference of I.E.S., to be held in Atlanta, Georgia, September 9-13, were mailed to all Society members during June. Register early for this top I.E.S. meeting.

Converter Equipment

By SHELLEY KRASNOW

This article describes a rotating type of frequency converter especially developed for high frequency fluorescent lighting.

Most of the elements used in high frequency lighting are familiar to illuminating engineers. The lamps, sockets and fixtures are much the same as for 60-cycle operation. The one exception, and the welcome one, is the ballast. It has proved possible to use a capacitor ballast, thereby substantially reducing the size and weight of this unit, in turn making it possible to use a lighter-weight luminaire and lighter fixture-supporting structures.

The capacitor ballasts themselves are not unusual, being quite familiar to the electrician. Capacitors have been used for power factor correction in connection with other fluorescent lighting applications and are, therefore, familiar to the illuminating engineer. The one element which is apt to be unfamiliar is the rotating type of frequency converter. It is this component which is described.

Much of the original work in high frequency fluorescent lighting systems had been done with 360 and 400 cycles, because of the semi-standard character of these frequencies for other applications. It is well recognized that even higher frequencies, up to 2000 cycles and even higher, would have been desirable, but the lack of commercially produced equipment for these frequencies discouraged the use of them. Moreover, at the higher frequencies, transmission and other difficulties begin to be conspicuous, thereby further discouraging their application.

In the converter described, a frequency of 840 cycles was selected as an acceptable compromise. The wisdom of this selection has been borne out by actual operating experience. While the performance obtained with this frequency was significantly better than that obtained with 400 cycles, the additional loss in transmission of the high frequency power was minor as compared with 400 cycles.

It had been found also in previous work, that the addition of harmonics to the fundamental wave used in energizing a high frequency system could be used to simulate the effect of higher fundamental frequencies. Thus a lower frequency wave with harmonics gave results very closely approaching a sine wave of a much higher frequency. This is another way of saying that a specific non-sinusoidal wave was attained. Advantage was taken of this also, in the converter described.

A converter, to be practical for commercial high frequency lighting, must meet the following requirements:

1. It should have a high conversion efficiency.
2. It should be capable of continuous operation for long periods without attention.
3. It should be simple and involve no maintenance problems unfamiliar to the average building maintenance man or electrician.
4. It should have no delicate regulator or other vulnerable auxiliaries.
5. It should be insensitive to input line voltage variations.
6. It should have a long life.
7. It should, except for possible replacement of bearings, not require replacement of parts during its life.
8. It should be self-protecting against overloads and short circuits.
9. It should have a wave form especially suitable for high frequency fluorescent lighting.
10. It should require very infrequent and very brief shutdowns for maintenance or inspection.
11. It should be capable of 24-hour-per-day duty over periods of years.

At the time that the requirement for a frequency converter for this service developed, the permanent magnet generator, although new, was in an advanced state of development and sufficiently proved so that it could be produced for commercial usage. The decision was therefore made to construct a 30-kva complete motor generator unit, employing the permanent magnet brushless generator as the generating element. Because of the conditions of use of the converter, the elimination of brushes and their attendant maintenance was especially attractive.

Author: Gorator Corporation, Manassas, Virginia.

Figure 1.

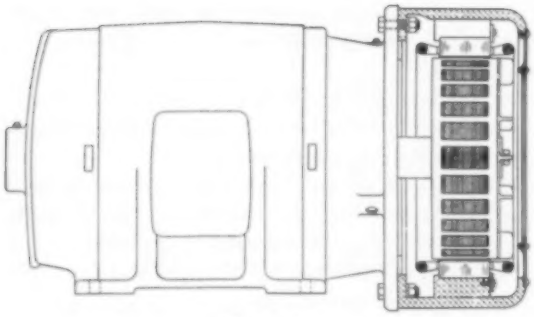


Figure 2.

Fig. 1 shows the external view of this converter. Fig. 2 is a cross-section, giving the internal construction of the converter.

Basically, the converter consists of a 60-cycle continuous duty induction motor, operating at 3600 rpm. To the housing of this motor, at one end, is bolted the housing and stator of the 840-cycle generator. The latter has a rotor with 28 poles, mounted upon the shaft of the motor. The rotor is a composite structure cast in aluminum, containing the steel and permanent magnet elements necessary to give the required magnetic field. The rotating structure has no windings and therefore does not require any brushes, slip-rings, commutator, exciter, etc. Because of this construction, the entire assemblage is scarcely longer than the motor with its shaft alone and has no bearings other than those required for the motor alone. In fact, the floor room taken by the complete converter was practically that of the motor alone. The actual floor area was 22 by 30 inches.

The rotor of the machine is shown in Fig. 3. This is seen to be a cast aluminum wheel mounted upon a steel hub. The rotation of this rotor at 3600 rpm gives 840 cycles. The motor of the unit is 3-phase and provided to work from a standard 3-phase, 60-cycle voltage. The generator is also wound 3-phase, but each of the three phases is independent of the others, being completely insulated from them. The individual phase voltages are either 400 or 600, depending upon the voltage required for the system. It is believed that most of the systems will utilize a 600-volt output in order to take advantage of 96-inch lamps.

The center point of each phase is connected to a common ground, so that no terminal in the entire lighting system is more than 300 volts above ground. This brings the system into conformity with Underwriters' requirements, which forbid a voltage higher than 300 above ground. The individual phases are each connected to their respective circuits.

Because of the construction of the machine, each of the phases can be loaded independently of the others without significant interaction. As will be described more fully later, the machine does not require a regulator. The absence of the regulator obviates one of the difficulties that might be encountered with the usual type of machine, in which an attempt to maintain voltage for one phase would cause the voltage for the other phases to vary greatly, if they were loaded either more or less than the monitoring phase. The use of the three independent phases, rather than a single phase, enables a far greater amount of power to be taken from a given frame size of a generator of this type.

Figure 3.

The overall dimensions of the unit are 30 by 18 by 22 inches, and the total weight, 515 pounds.

As was stated earlier, the generated wave form delivered by the converter is important, if maximum effectiveness is to be obtained. The wave form sought for in most ordinary generator applications is a pure sine wave. This may be regarded, for certain high frequency fluorescent lighting circuits as adequate, but not ideal. In general, it may be stated that departure from a pure sine wave — in the proper direction — is desirable if ideal performance is to be attained.

The attainment of the ideal wave form is considered as devolving upon the converter designer. The internal construction of the converter should be such that, in conjunction with the specified load, the desired wave form is attained without any external wave-modifying circuits.

In some of the circuits employed currently, the load is dominantly capacitive, due to the use of capacitor ballasting. For such circuits, the weight of opinion is that the wave form delivered by the converter should be triangular, which will in turn cause flow of a square wave of current through the capacitor and lamp combination.

The attainment of this (or any other wave form) may be looked upon as the combination of harmonic frequencies of proper amplitude for each respective harmonic. The performance of the frequency converter for fluorescent lighting application will be dependent, in part, upon the degree to which this ideal is attained.

The use of a rotating permanent magnet structure in the converter, in place of a wound field, gives a much higher conversion efficiency, since the field losses are completely eliminated The armature winding is also more efficient. This gives a higher overall conversion efficiency. By the same token, since inefficiency appears as heat, the temperature rise is moderate, so that elaborate cooling is not required. Under full load, the measured temperature rise was only 11 degrees, Centigrade.

The absence of brushes, exciter and regulator allows the machine to be operated for long periods without attention of any sort and to obviate the need for skilled maintenance. The only parts likely to require attention or maintenance are the bearings, which ordinarily require lubrication at intervals of about a year. In event of failure of the bearings, an occurence no more or less likely than with motors driving other types of generators, diagnosis and correction of trouble can be affected by average motor repair personnel.

One of the important characteristics of the permanent magnet type of generator is its good intrinsic voltage stability. If the load were corrected to unity power factor, the voltage would remain within plus or minus 4 per cent of its stated value, for any condition of load within the rating of the machine. This variation of voltage decreases, if the power factor is leading. With a power factor of approximately .85 leading, the regulation is practically zero. This means that the machine will maintain the same terminal voltage, regardless of the kva load.

The capacitor ballasts, which are the preferred type because of their light weight and economical construction, in combination with the lamps, give a net power factor of .30. By the use of chokes or inductors for a group of lamps, the net power factor can be brought to a higher figure, leading. When it has been adjusted to a value of about .85, the generator will then deliver practically constant voltage, whatever the load. It is again emphasized that this is accomplished without any regulating device.

The correction to a net leading power factor actually results in improved economy. The choke or inductor required to correct to that power factor will be smaller than if it were attempted to bring the power factor to unity. In fact, if a slight voltage rise can be tolerated, the correction need not even be as good as .85 leading. It is also remarked here that it is not necessary to correct small groups of lamps, which may be switched on independently of the others, since the total effect of these on the overall voltage of the system will be relatively small.

Another advantage of the rotating type of generator as detailed above, is its relative immunity to changes in input voltage. The speed of operation of the motor will depend chiefly upon the frequency and this is usually very constant in most applications. The output voltage of the permanent magnet brushless generator, is dependent only upon the load and the driving speed. The latter depends practically only on the frequency, with a properly designed induction motor as drive. It follows that if the machine is made insensitive to voltage change due to varying load, by correction of power factor as noted above, and if the input frequency is substantially constant, the input voltage to the driving motor will have very little effect on output. Thus, the output voltage will remain stable to within better than plus or minus one per cent, even with input voltage changes as great as 15 per cent. Moreover, the throwing on or off of heavy loads on the input side, such as by the starting or stopping of large motors, will not produce any flicker in the lighting. This is a very important consideration

in installations where the circuit feeding the lighting converters must operate other intermittently operated 60-cycle heavy equipment. The inertia of the rotating parts of the motor generator serves to smooth out these disturbances, so that they are totally imperceptible in the lamps themselves.

Another advantage of the motor generator type of converter discussed is its self-protecting feature. In the event of an accidental short circuit, the generator will not be injured, since it can stand such a short circuit for an indefinite period. This makes it unnecessary to provide protective devices for the generator itself, the only ones required being to protect the line leading to the load. The total short circuit current is a maximum of about four times normal full load current. If the line is designed to stand such higher current, it will be unnecessary to provide protective devices, even for the line.

The converter will thus prevent or minimize damage in the event of failure of protective devices.

Since the 3-phase windings of the machine are all electrically independent of each other, they can be wound for different voltages. Thus, one phase may deliver a voltage of 400 suitable for a group of short lamps, while the other phase can be wound for 600 volts to supply a group of longer lamps. By the same token, it is possible to tap the winding of a 600 volt machine, so that a number of 400-volt lamps can be operated from it.

Successful use of the converter described in a commercial installation has prompted plans for its more extensive use in still larger installations.

Work is currently in progress on modifications of lighting circuits and ballasting. Some of these modifications may require consequent modification in the rotating type of converter, chiefly in the specific wave form generated. There is no reason, on the basis of past experience, to anticipate difficulty in that direction in the rotating, permanent magnet type of converter.

Whatever specific form the permanent magnet converter may take, expectations are that it will offer for high frequency fluorescent lighting applications, the combination of durability, dependability and economy.

Industrial Area, Before and After

At the Hyster Company plant in Peoria, Illinois, the high-bay installation in the background provides an interesting contrast with the lighting system it replaces. For both the high-bay area, background center, and the low-bay area to the left background, high levels are obtained from two-lamp eight-foot luminaires having a 20 per cent upward component, and using 480-volt ballast. Light-colored surfaces have, of course, been provided for suitable brightness balance. Another feature of the installation is a group replacement and maintenance program, on a 12-month basis, which is included in the three-year amortization of all costs.

The installation was designed by Delwin Schneider, Service Sales Engineer for the Central Illinois Light Company, Peoria, and took second prize in the Central Illinois Chapter contest for My Most Interesting Lighting Job, 1957.

INSTALLATION IN RESIDENCE OF MR. & MRS. MATTHEW B. WEINSTEIN, MERION, PA.

"Twinkling" Lighting for a Dining Room

LIGHTING OBJECTIVE: To provide unique decoration lighting in a subtle manner for a formal dining room.

GENERAL INFORMATION: This room measures 22½ by 18 feet. Ceiling height is 9 feet. The long exterior wall is plate glass from floor to ceiling, covered by a beige and white sheeer fabric (60 per cent reflectanec); the wall opposite is a series of sliding glass doors opening onto an enclosed patio. (The photograph above was taken from the patio through these sliding glass panels.) The end wall is panelled with natural-finish mahogany, wall between dining and living room (not shown in photo) is covered with a beige silk (45 per cent reflectance), ceiling is covered with white textured silk, and over the terrazzo floor is an oriental rug predominately rust and gold.

INSTALLATION: Incandescent lamps were chosen as the sole light source in this room. General lighting reflected from the draperies along the outside wall is provided by four recessed angle-louvered Gotham units #575 each containing one 75-watt R30 flood lamp. In addition, two 250-watt Kliegl #2150 adjustable shutter pinpoint spots are recessed in the ceiling over the table and framed to illuminate just the table top. These units render the table the major focal point of the

(over)

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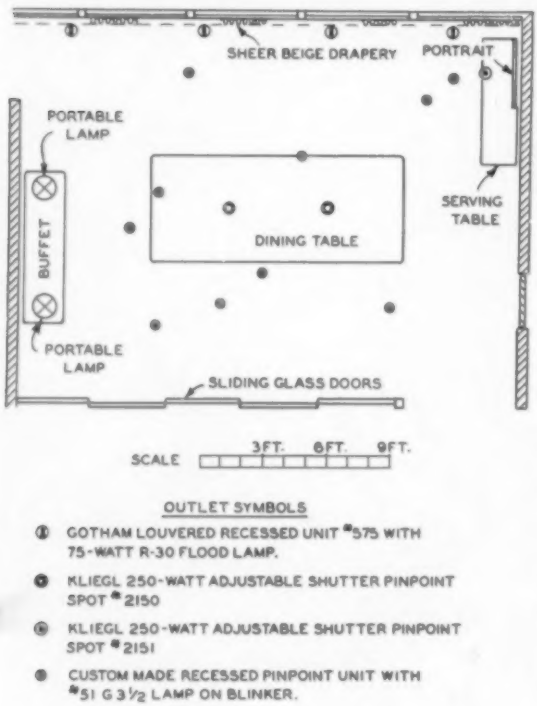

SHEER BEIGE DRAPERY
PORTRAIT
PORTABLE LAMP
BUFFET
DINING TABLE
SERVING TABLE
PORTABLE LAMP
SLIDING GLASS DOORS
SCALE 3FT. 6FT. 9FT.
OUTLET SYMBOLS
GOTHAM LOUVERED RECESSED UNIT #575 WITH 75-WATT R-30 FLOOD LAMP.
KLIEGL 250-WATT ADJUSTABLE SHUTTER PINPOINT SPOT #2150
KLIEGL 250-WATT ADJUSTABLE SHUTTER PINPOINT SPOT #2151
CUSTOM MADE RECESSED PINPOINT UNIT WITH #51 G 3½ LAMP ON BLINKER.

Figure 2. (left) Plan view showing locations of all lighting equipment.

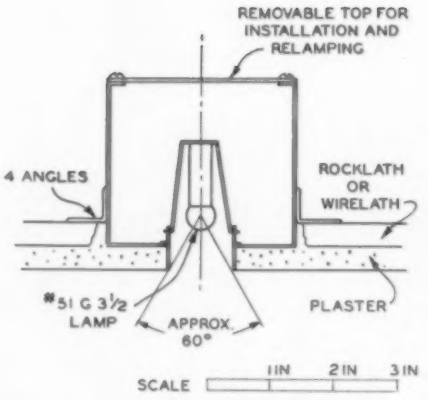


Figure 3. (above) Detail of custom-made ceiling pin hole light.

room and cause the crystal and silver to sparkle and glow, casting interesting patterns on the ceiling. This effect would be too dramatic for comfort and unkind to the appearance of people seated around the table, were it not softened by the drapery and patio lighting. Table top illumination averages 10 footcandles. Another similar shuttered unit (Kliegl #2151) is recessed in the ceiling and adjusted so all its light falls on the life-size portrait.

The pièce de résistance in this dining room, lightingwise, is a twinkling "starlight" system made up of ten custom-made (Klemm Reflector Company, Philadelphia) pinpoint fixtures as shown in Fig. 3. The 7.5-volt #51 G-3½ lamps are operated at 6 volts on a blinker circuit composed of a series of five contacts which turn on two lamps at a time for two seconds. One is pleasantly aware of the resulting twinkling effect, not startled by it; the family and guests find the slow tempo of changing light very relaxing.

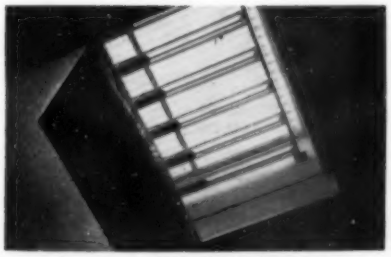
(All recessed units in this room are relamped from above.)

Architect: Frederick Wise, Philadelphia. Lighting designed by Elizabeth A. Meehan, Philadelphia Electric Co.

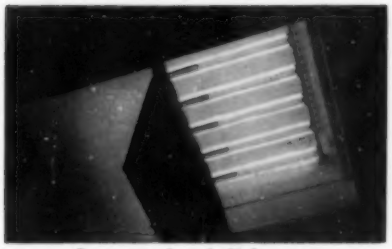
Lighting data submitted by Elizabeth A. Meehan as one solution to a lighting problem and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Plastic sky domes in this gymnasium have been adapted to serve also as recessed luminaires for a fluorescent lighting system. Unique arrangement of adjustable louver blades within the unit permits a choice of lighting systems . . . daylight alone (louvers open, lights off) . . . electric light only (louvers closed, lamps on) . . . a combination of both.



Louvers open, daylight only.



Louvers closed, lights on.

High levels from combination.

ARTIFICIAL DAYLIGHT in a School Gymnasium

By HAROLD H. FRIEDMAN

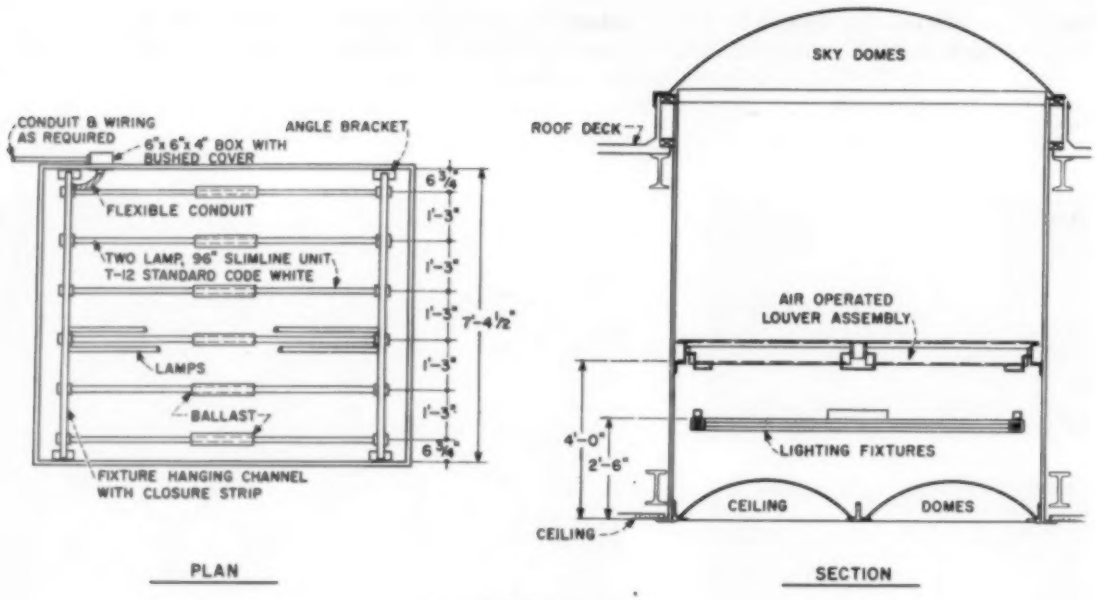
It appeared, when the plans for the Maple Hill High School, Castleton-on-Hudson, N. Y., first reached my desk, that the gymnasium especially, offered all of the problems which in one form or another crop up in most schools being designed today. For one thing, it was designed for multiple occupancy ranging from physical education and inter-school sports competition, to school auditorium meeting room, and community theatre. Further, the gymnasium could be made into two separate rooms, each with its own occupancy and activity, and of course, lighting requirements. To complete the circle, it was desirable to have room available for emergency classroom space.

Lighting requirements in these circumstances varied: from the high levels needed for sports; comfortable levels and quality required for classroom activity; on down to the reduced levels of illumination suitable for auditoriums. Blackout requirements for daytime motion picture projection were also a must, although not necessarily a lighting design problem.

In the solution of a problem such as this, many thoughts spend their time in a designer's mind. The quality possible with large area fluorescent lighting—excellent for seeing and pleasing to the eye—but a hazard to a school board's limited fund. The quantity available for a modest sum from high level high bay lighting—but with distribution unsuitable for classroom use or the subdued illumination desirable for a school and community meeting room. The more usual installations of past practice were not transferable in total to the Maple Hill gym. It was necessary to look for a new solution, perhaps based on the building structure itself.

The room was 70 by 90 feet with a 24-foot ceiling spotted with twelve 88-inch by 106-inch sky-

This installation won First Prize in the 1956 competition for My Most Interesting Lighting Job, Eastern New York Section. Author: Consulting Engineer, Albany, N. Y.



Detail of skydome unit.

lights using plastic domes. It was decided that a close approach to large area lighting units could be had here at little cost to the electrical contract, by simply mounting fluorescent lamps above the translucent bottoms of the skylights. A reflecting surface other than the top clear surface of the Plexiglas was desirable, and as will be seen from the illustrations, this too was added at no particularly great increase in cost. We then did have the parameters necessary for lighting design, and our initial computations indicated we could obtain a level of 35 to 40 footcandles.

Detailed drawings from which this installation was made are shown above. A total of six two-lamp 96-inch T12 fluorescent fixtures were thus developed, consisting of nothing more than spline-back mounting the ballast and wiring and the end pieces for sockets. The units are installed one-foot three-inches on center, and switched alternately to provide half or full intensity of illumination in accordance with the occupancy of the room. The section view gives the crux of the design—clear Plexiglas top panel, pneumatic-operated louver assembly, and lamps mounted to provide approximately two-foot clearance above the translucent Plexiglas bottom panels. Incidentally, the louver assembly is no stranger to school construction and is quite commonly used in heating and ventilating work for modulated air flow control. The pneumatic operation of the louver assembly is also no coincidence. The mechanism is a relatively trouble free air operated motor which required no maintenance to speak of and hence could be mounted above the ceiling outside the dome. The air supply for this motor was easily found in the pneumatic temperature control system.

The louver blades and assembly were painted gloss white for high reflectance which gives good pass-through characteristics for daylighting, as well as excellent reflecting surfaces when in the closed position. It might be mentioned here, that with the louvers closed and the lights off, the black-out available solved a neat architectural design problem, and without the use of the maze of pull curtains, cords and rollers so often required in similar circumstances.

As can also be noted, the bottom lights of the dome are in two sections for ease of maintenance.

The school building of which this gymnasium was a part was designed by W. Parker Dodge, Architect, of Rensselaer, New York, with whom it has been our good fortune to have worked many times past and since.

A Field Check on School Lighting Costs

By WILLARD ALLPHIN

THEORETICAL comparisons are often made between the costs of operating incandescent and fluorescent lighting systems in schoolrooms, but opportunities to make actual comparisons on completely comparable basis are not too common. In the fall of 1956 the Town of Danvers, Massachusetts, opened two new schools in which such a comparison became possible.

Due to topography, the schools differ in the arrangement of their administrative areas and in the two classrooms associated therewith, but each school has a similarly oriented wing containing eight classrooms, and these wings are identical except for the lighting.

The original lighting layout called for nine 300-watt incandescent luminaires per classroom. This was insufficient to meet the American Standard Practice for School Lighting; but the architect's engineer was reluctant to use larger than 300-watt lamps on account of the heat given off. Also there was the feeling (not shared by this author) that the extra daylight from clerestory windows would make a full-size electric installation unnecessary. Actually, a previously reported study showed that schools in the same part of New England needed full-size electrical installations even though extra daylight was provided,[1] because of a significant number of dark days in winter.

When the matter was reconsidered, the lighting had already been installed at the Riverside School, so it was decided to use fluorescent in the classrooms at the Highlands School and compare the results there with those at Riverside. The fluorescent layout has one row of seven luminaires, one of six and one of five, the different row lengths resultings from conflicts with exposed air ducts. The area of lower illumination due to the shorter rows occurs at the rear of the room, where it is not too important.

A sub-meter was installed at each school to meter the electricity used in the classroom wing. This included some power for small motors in unit heaters and ventilators, but the small power load is identical in the two buildings.

Footcandle readings in one room of each wing and kilowatt hour readings for each wing were taken at two-and-three-week intervals, at night, throughout the school year by a senior science stu-

AUTHOR: Sylvania Electric Products Inc., Salem, Mass.

Test room at Riverside School, Danvers, Mass.

Test room at Highlands School, Danvers, Mass.

TABLE I.

	Incandescent	Fluorescent
1. Connected load per classroom	2.7 kw	1.8 kw
2. Connected load for 8-room wing	21.6 kw	14.4 kw
3. Actual consumption in 32 weeks	17,400 kwh	14,230 kwh
4. Probable consumption in 40 weeks	20,000 kwh	16,500 kwh
5. Average illumination initially	20 ft-c	54 ft-c
6. Average illumination after 32 weeks	17 ft-c	46 ft-c
7. Projected average illumination after 40 weeks	16 ft-c	44 ft-c
8. Load per classroom for 21 fluorescent luminaires	2.7 kw	2.1 kw
9. Load per classroom, prorated to produce 30 ft-c after 40 weeks	5.07 kw	1.43 kw
10. Estimated consumption for 8 classrooms in 40 weeks, with load as in No. 9	37,500 kwh	11,300 kwh

dent from the Danvers high school. At the beginning of the study each test room was measured by the I.E.S. Standard Interior Lighting Survey Procedure,[2] and a desk was selected which had the same illumination as the room average. This desk, relocated precisely, was used thereafter for the repeated readings. At the end of the year the rooms were measured again by the I.E.S. Standard Procedure to make sure that the test desk still represented the average. Also the test meter was recalibrated from time to time.

The Superintendent of Schools had the principals speak to the teachers at the beginning of the school year about turning lights out when they were not needed. Nothing was said about a test being in progress, and no unusually strong drive was made to reduce electricity consumption. Both schools were handled in the same manner, and it was attempted to use only a normal degree of admonition.

It was not possible to start the observations at the beginning of the school year, but readings were obtained over a period of 32 weeks. Since many school systems clean the luminaires only in the summer, the footcandle values can be projected to a 40-week period in order to estimate the minimums. The luminaires were not cleaned or relamped during the 32 weeks.

The fluorescent installation started at 54 footcandles and declined to 46 in the 32 weeks. At this rate it would have been 44 after 40 weeks.

The incandescent installation started at 20 footcandles and declined to 17 in 32 weeks. At this rate it would have declined to 16 in 40 weeks.

It seems evident that for locations as clean as these, present maintenance factors used in lighting calculations are too conservative.

The connected load for the fluorescent installation is 1800 watts per classroom, but would have been 2100 watts if the air ducts had permitted three full rows of luminaires. The additional three luminaires would have raised the footcandle level a little as determined by the I.E.S. standard procedure. The connected load for the incandescent system is 2700 watts per classroom.

Prorating the projected final values of 44 and 16 footcandles to 30 footcandles, the fluorescent lighting would have required a load of 1430 watts and the incandescent lighting a load of 5070 watts.

The eight classrooms having incandescent lighting used 17,400 kwh in 32 weeks, while the eight classrooms having fluorescent lighting used 14,230 kwh.

Prorating these consumptions to 40 weeks would give 21,700 kwh for the incandescent installation and 17,800 for the fluorescent, but these would probably be too high on account of the greater availability of daylight in the fall and spring. Making a suitable correction for this might bring the figures down to 20,000 and 16,500. These in turn, prorated to 30 footcandles after 40 weeks, would become 37,600 kwh and 13,500 kwh.

Summary

Results and projections are summarized in the table and the basic data are contained in lines 1, 3 and 6. The estimates are of course open to debate, and the reader may prefer to make his own. For example, No. 10 may exaggerate the difference, because with a heavier incandescent load the installation might have been operated less; and with a lighter fluorescent load, that installation might have been operated more.

Thanks are extended to the Danvers School Committee for permission to make the test, to Superintendent Clifford J. Good for his cooperation, and to Richard N. Finochio, the student who made the readings.

References

1. Allphin, Willard: "Daylight Measurements in Six New England Schools," ILLUMINATING ENGINEERING, Vol. L, No. 10, p. 462 (October 1955).
2. I.E.S. Lighting Handbook, pp. 4-5 to 4-8.

Effect of Outer Jacket Fill Pressure And Arc Tube Pressure on

Mercury Lamp Performance

By J. M. HARRIS

A HIGH PRESSURE mercury vapor lamp consists of two basic parts: the light producing source, or arc tube, mounted in a supporting frame and an outer jacket to protect the arc tube. There is a space between the glass outer jacket and the arc tube. The type and pressure of the gas that fills this space has a direct bearing on the operation of the arc tube.

The arc tube itself contains the active mercury vapor when the lamp is in operation and a partial vacuum when the lamp is not in operation. The final operating pressure of the arc tube partially determines the color and efficiency of the light source. The cleanliness or transparency of the arc chamber itself determines the wavelengths of energy to be transmitted from the arc stream and how efficient that transmission will be.

Importance of the Outer Jacket

The inner element or arc tube is the heart of the high pressure mercury vapor lamp. This element is the actual light source. As long as it remains intact the mercury vapor lamp will continue to operate.

All mercury arc tubes have the same basic construction. The A-H1 type is made of hard glass with rods of molybdenum sealed in glass for electrical connections. Most of the lamps, however, have a quartz arc tube with very thin molybdenum strips sealed in vycor for electrical connections.

It is important that the arc tube be kept in an inert atmosphere. Any inactive gas could be used, but nitrogen was chosen because of its inactive nature at the operating temperature, cost, and its high ionization potential. An inert atmosphere is required to prevent oxidation of arc tube support and molybdenum sealing and connecting ribbons. If an oxide were allowed to build up on these leads it would creep along the lead into the glass to metal seals. As the oxide progressed, it would cause a mismatch between the glass and the sealing metal great enough to split the portion of the arc tube continguous to the seal. For this reason the arc tube would fail because the outer jacket was opened to the atmosphere. The time required for the arc tube to split is determined by the rate at which the oxide builds up on the electrical lead-ins.

Of fundamental importance is the pressure to which the outer jacket is filled. Fill pressure affects several of the operating parameters of the lamp.

(a) Run-up and restrike time,

(b) Arc over voltage in the outer jacket.

Run-Up and Restrike Time

In a perfect vacuum, the only way that heat may be transferred is by radiation. If gas is added, heat can also be transferred by convection, conduction, or both. If a hard vacuum were pumped in the outer jacket of a mercury lamp, the arc tube would tend to lose heat only through radiation as it warmed up to its operating temperature. The heat generated by the arc tube is required to evaporate the metallic mercury in a cold lamp. The more rapidly it is evaporated the quicker the arc tube comes up to pressure. Since nitrogen is necessary in the outer jacket for proper lamp operation, the amount of gas in the outer jacket has an influence on the run-up time. As the fill pressure is increased, more heat is taken from the arc tube and a longer time is required to overcome the additional heat loss.

Fig. 1 is a plot of outer jacket fill presure vs per cent increase in warm-up time. This plot was made by taking a cross-section of the industry's arc tubes and reading the warm-up time when the fill pressure in the outer jacket was varied from 20 microns to 1 atmosphere. Generally, the graph shows that for shortest warm-up time the outer jacket should be filled at a low pressure.

A power interruption even for a time as short as $^1/_{60}$ second may cause the lamp to extinguish. There must always be a sufficient minimum voltage

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 17-21, 1956, Boston, Mass. AUTHOR: General Engineering Dept., Sylvania Electric Products Inc., Salem, Mass.

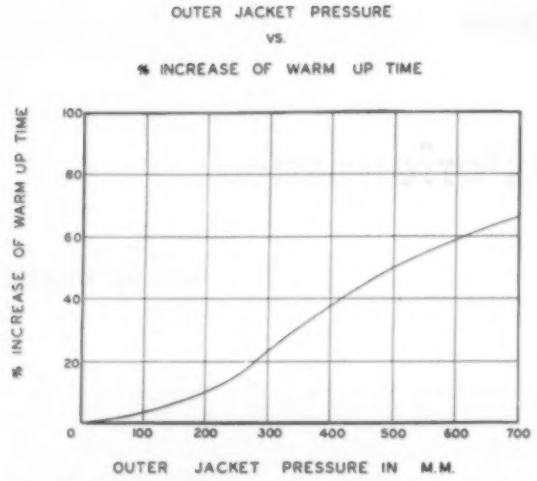


Figure 1. Outer jacket pressure rs per cent increase of warm-up time.

applied to the arc tube and the ballasting network to keep the lamp in operation. A rule of thumb is that the arc tube voltage (usually 137 volts) plus 45 volts across the ballast are required to keep the lamp from extinguishing. Under controllable conditions, the voltage may be less than stated in the rule of thumb for short periods of time. In Fig. 2 are shown data collected from 75 lamps, equally divided from three different manufacturers, at various stages of life. The solid lines represent extinguishing characteristics of a standard indoor ballast with 220 volts open circuit which has its primary voltage temporarily reduced to specific percentages of normal line voltage. The number of cycles involved was recorded on an oscillograph. This was done by switching the input to various percentages of primary voltage from 1 to 600 cycles. No data were recorded in excess of 600 cycles because the lamp had reached a stable state.

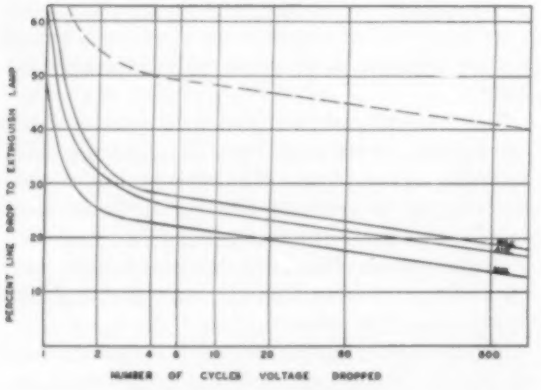


Figure 2. Data on 75 lamps.

The dotted line represents the extinguishing characteristics when an outdoor type ballast with an open circuit voltage of 300 volts is used. The important difference between the curves is the difference in percentage decrease of primary voltage required to cause lamps to extinguish. Although in both cases the knee of the curve occurs at approximately the same place, between 1 and 2 cycles, the primary voltage of the outdoor ballast may be dropped more than that of the indoor type ballast. When the line voltage drops in excess of 30 per cent for 2 cycles or more, all lamps operated on an indoor ballast would extinguish. A maximum and a minimum curve is given to take into consideration the variation of arc tube construction and arc tube voltage. The nominal arc tube voltage for the E-H1 is 137 volts with a standard allowable industry variation of ±15 volts.

When a mercury lamp's power has been interrupted and the arc extinguishes, several minutes are required before the lamp will restrike. The mercury in the arc tube that has vaporized must condense so that the pressure in the arc tube will be lowered. Since the voltage required to strike is a function of arc tube pressure, the lamp will restrike when sufficient mercury has condensed. The speed of mercury condensation is not appreciably affected by surroundings of the lamp because the fill gas has an insulating effect. The amount of fill gas was found to have little effect on the time required before restrike. Fig. 3 is a plot of fill pressure vs restrike time. Standard lamps from three manufacturers were filled at outer jacket pressures between 20 microns and 1 atmosphere and burned for 20 minutes. The power was interrupted and the time to restrike recorded. There is a slightly shorter time required for restrike as outer jacket fill pressure is increased, but not enough to require that mercury lamps have such high fill pressure.

Effect of Fill Pressure On Arc Over Voltage

With indoor operation, the maximum open circuit voltage applied to a mercury lamp is 220 volts. In outdoor operation, the open circuit voltage may run as high as 300 to 350 volts. With series circuits the open circuit voltages may be higher. It is important that the mercury lamp be able to withstand all of the normal voltages that are applied to it plus any abnormal voltage up to and exceeding the rating of the normal lamp protection devices.

The fill pressure in the outer jacket of a mercury lamp has a direct relationship to the voltage required to cause an arc between the lead wires and supporting frame. When the lamp is cold, there is

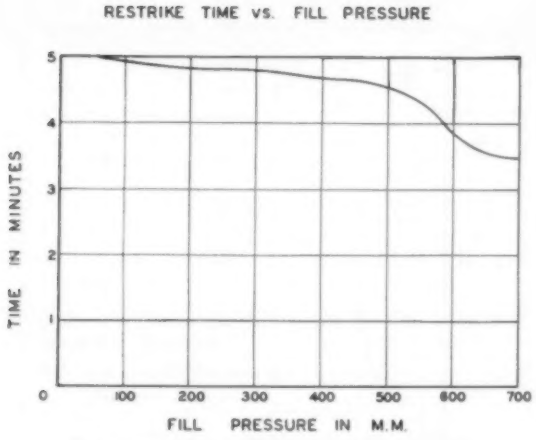


Figure 3. Restrike time vs fill pressure.

little problem because the lowest impedance path within the outer jacket is between the electrodes. However, if power has been interrupted or if there is some abnormal line condition, a high voltage applied to a hot lamp may cause an arc between the closest elements within the outer jacket. Fig. 4 is a plot of arc over voltage vs outer jacket fill pressure. In this plot are represented 50 Sylvania lamps where the outer jacket fill pressure was varied in discrete steps between 20 microns and atmospheric pressure. In this test, lamps were burned for 20 minutes and the power was shut off. A voltage of 100 volts was immediately reapplied. Lamp voltage was increased at the rate of 200 volts per second until the lamp arced over between the two closest points. A suitable transformer was selected so that as the hot lamp arced, the voltage dropped, thus preventing the tube from being destroyed. It was necessary to preserve the lamp so it could be tested at another fill pressure.

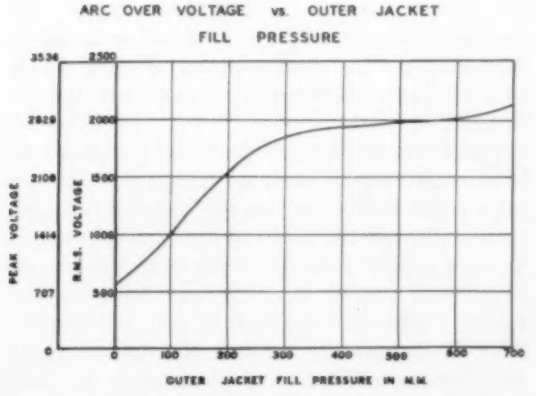


Figure 4. Arc over voltage vs outer jacket fill pressure.

At a pressure of 20 microns with the lowest open circuit voltage applied, 100 volts, there is a glow discharge between the frame and lead wires. This glow disappears as the pressure is increased. From this point on, the arc over is a function of fill pressure.

As the fill pressure is increased to about 350 mm the slope of the curve begins to level off. From this point on there is little decrease in the arc over voltage as the fill pressure is further increased. From Fig. 1, fill pressure has a direct effect on warm-up time. At pressures greater than 350 mm warm-up time increases rapidly. Since the change in arc over voltage is slight above 350 mm and the increase in warm-up time is appreciable, this value of 350 mm has been chosen as the most suitable compromise between arc over voltage magnitude and run-up time. In Fig. 4, the rms value and peak value of the sine wave are both plotted on the ordinate. The peak value is important because many of the waveforms applied to the mercury lamp are not sinusoidal.

The physical location of the elements in the outer jacket can not be disregarded. It is important that the areas of highest potential difference be separated as much as possible. In case there is a high voltage surge, the arc over voltage is a function of outer jacket fill pressure, but is limited by the spacing between the closest elements.

Effect of Arc Tube Pressure

The operating pressure of the arc tube has an effect on lamp operation. The principal effects of operating pressure are:

(a) Color,
(b) Efficiency,
(c) Life.

Mercury vapor sources do not produce a continuous spectrum of light at the lower pressures, but instead produce discrete bands of energy with the intensity being associated with arc tube pressure. The lowest pressure normally used in a mercury vapor source is in the fluorescent lamp which by itself generates mainly ultraviolet energy. This energy in turn is converted to light by use of phosphors. The fluorescent tube without its coating has only 2 per cent of its energy which is visible. The vapor pressure of mercury in the fluorescent lamp is about 10 microns and represents the most efficient pressure to produce radiant energy of 254 mμ wavelength. The next area of useful energy production is 1 atmosphere and above. The curve in Fig. 5 shows the theoretical amounts of energy that are generated at various arc tube pressures. The lowest pressure mercury lamp in the high pressure class is

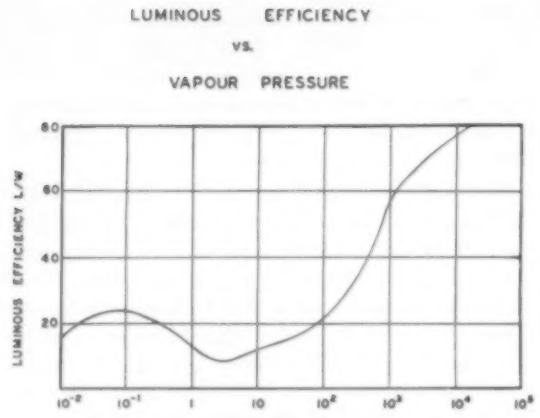


Figure 5. Luminous efficiency vs vapor pressure.

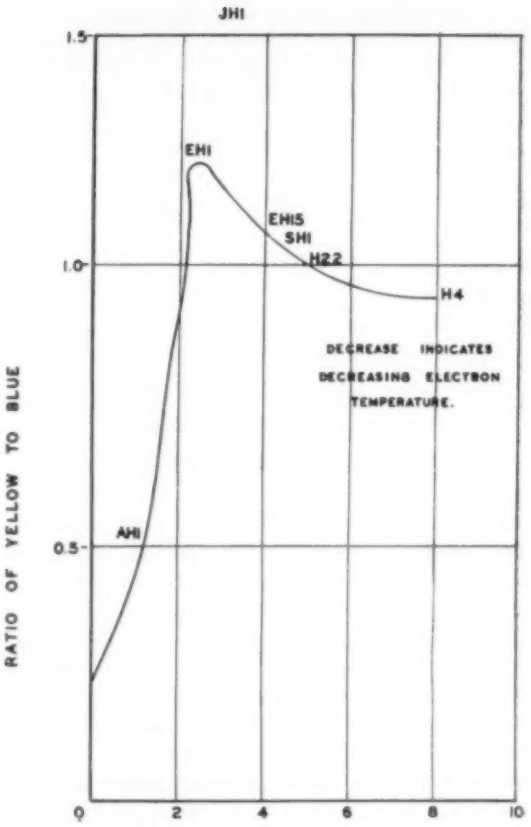


Figure 6. Ratio of yellow to blue light vs arc tube pressure.

the A-H1 with the hard glass arc tube. This lamp has a normal operating pressure of 1.2 atmospheres. With the advent of the quartz arc tube, the 400-watt E-H1 lamp was made with an arc tube pressure of 2.5 atmospheres.

Besides the 400-watt quartz lamp, lamps with quartz arc tubes have been developed with wattages between 100 and 1000 watts. Each one of these arc tubes has its own operating pressure which is primarily dependent upon arc tube diameter, and the voltage gradient between the electrodes.

To describe the color produced by the mercury arc running at pressures greater than one atmosphere it must be realized that there are four principal lines associated with the bare arc tube: 405 millimicron, violet; 436 millimicron, blue; 546 millimicron, green; 578 millimicron, yellow.

With the spectral radiometer it is possible to record the energy emitted by any given light source. Plots of light intensity vs frequency show a difference in the radiation intensity at varying arc pressures. A sensitive indication of the comparative color of light emitted can be obtained by plotting the ratio of yellow to blue light (578/436) vs arc tube pressure. See Fig. 6. Starting with the fluorescent lamp the yellow is much less than the blue. With increasing pressure the proportion of yellow increases until it is maximum at the operating pressure of the E-H1 arc tube. From this point on, the ratio of yellow to blue starts to decrease with increasing pressure due to the decreasing electron temperature. It would appear then that, above approximately 2.5 atmospheres, the ratio of energy in the longer wavelength decreases and the energy in the shorter wavelength increases.

These conclusions are borne out by results obtained by W. Elenbaas.[1] He shows that as the arc tube pressure increases, the energy at the long wavelengths is attenuated while the magnitude of the shorter wavelengths is increased. He further points out that as arc tube pressure increases the lines of energy become broader and at very high pressure take on the form of a continuum with the major share of the energy in the blue region. Therefore, in conjunction with Fig. 5, as the arc tube pressure is increased the ratio of yellow to blue is decreased, but the total quantity of light or efficiency is improved due to the formation of the continuum.

The difference between the 2 and 8 atmospheres is too small to gain much advantage toward forming a continuum in the blue and green wavelengths. Only a little yellow is lost at the higher pressures. There is a more noticeable decrease of yellow in the lower pressures, as in A-H1 and fluorescent arc tubes. Under no condition of pressure may the color of the mercury arc be made orange or red. Only by the addition of a phosphor to the outer jacket may the color be supplemented. The conclu-

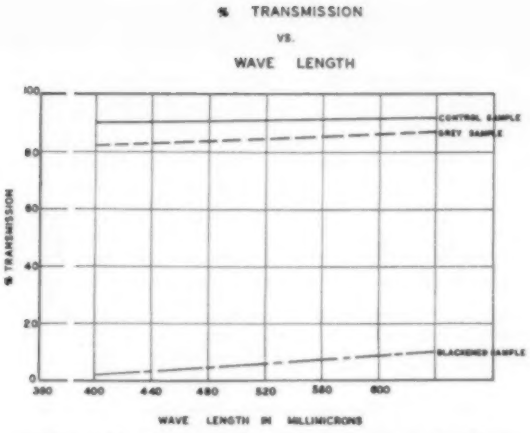


Figure 7. Per cent transmission vs wavelength.

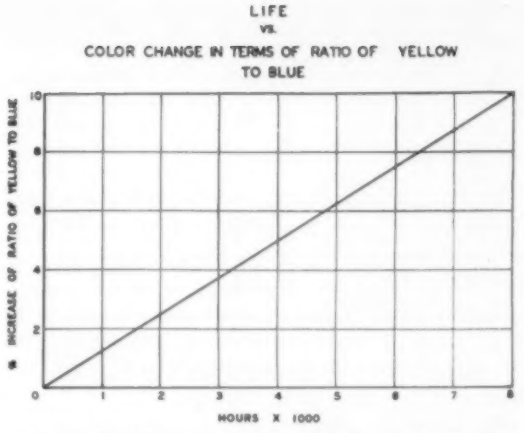


Figure 8. Life vs color change in terms of ratio of yellow to blue.

sion is, therefore, that there is no significant color difference between the various sizes of mercury lamps normally used for general and street lighting.

It is interesting to note that in Fig. 6, the ordinary J-H1 mercury lamp appears with a high ratio of yellow compared to blue. This occurs because the phosphor is activated by energy below 480 millimicrons. The latter wavelength is in the visible blue so that some of the light has merely changed its wavelength at the expense of visible light or efficiency. The S-H1, however, appears closer to the high pressure lamps. This happens due to the increase in yellow from the phosphor and because the orthophosphate phosphor is activated by ultraviolet below 3200 mμ at no expense to visible light.

Normal life has little effect on color. As life increases the tendency is for the ends of the arc tube to blacken. These black deposits cause a decrease of lumen output in proportion to the density of coating and the amount of the total arc tube that is coated. To determine the effect of life on lamp color, arc tubes with varying degrees of blackening were compared with clear quartz arc tubes. Two tests were set up to determine the effect of life on lamp color:

(1) The first was to measure clear quartz arc tubes for transmission at the wavelengths covered by the mercury lines and to measure arc tube samples taken from lamps at different stages of life. Any difference in per cent of transmission across the spectrum would indicate the amount of light absorbed by the arc tube discoloration.

(2) The second test was to measure on the spectral radiometer lamps initially, and at various stages of life, and compare their energy distribution.

The solid line in Fig. 7 represents the control arc tube of clear washed quartz. In the region of 360 millimicrons to 580 millimicrons (ultraviolet to yellow) the change in transmission is only 2 per cent. The 2 per cent represents practically no energy absorption at these wavelengths. The next step is to compare energy transmission of the control with arc tube samples that have run to the end of life. Two extremes in arc tube appearance were chosen to demonstrate transmission characteristics, the end of the arc tube where blackening is most pronounced, and the center of the arc tube where the arc tube is a light gray. The gray portion of the arc tube near the center has no effect on arc tube color. Light transmission on the average is cut down about 3 per cent and the difference in transmission between ultraviolet and 580 millimicrons is only 5 per cent, not a great deal different from the control. The dotted line in Fig. 7 compares the control and the gray quartz samples.

End blackening has an effect on both color and transmission. Fig. 7 compares the blackened section, dashed line, with the control and gray samples. By far, the most important effect of end blackening is overall transmission, but of the small amount of light transmitted through the blackened portion, transmission is better at the longer wavelengths.

The greatest discrimination against yellow compared to blue is where the ends are blackened. The ultimate change in color of the HPMV with life is very small because the greatest amount of light comes from the clearer sections that do not absorb any specific light energy. The alternate check for color change was to record the spectral energy distribution of new lamps before any signs of arc tube discoloration were in evidence. Then during their life span, periodic spectral energy distribution readings were taken, and the change in the ratio of

yellow to blue plotted. Fig. 8 shows a small color change with life. In this test, the ratio increases with life which shows less loss of transmission for the longer wavelengths.

Conclusion

The outer jacket fill gas must be inert to preserve all the metal parts it encloses. Any oxygen will cause oxidization of these components and eventual arc tube failure. The amount of fill gas is a compromise between warm-up time and arc over voltage. With all factors considered, this value, the optimum value, was usually chosen to be about ½ atmosphere or 350 mm of nitrogen.

The operating pressures of the arc tubes are the result of the physical requirements of the individual lamps and the standard arc tube voltage. There is little difference in color between any of the clear quartz lamps. The state of the arc chamber itself did, however, have a slight effect on color as it became discolored. By far the largest effect of arc tube discoloration was on lumen maintenance.

Acknowledgement

The author wishes to express his appreciation for the aid received from the various members of the Mercury Vapor engineering staff in Salem, Mass., and to various members of the General Engineering department for their assistance in running the many tests required in the various phases of this investigation.

Reference

1. Elenbaas, W.: "The High Pressure Mercury Vapour Discharge," North Holland Publishing Co., Amsterdam, 1951.

DISCUSSION

W. S. Till:* Mr. Harris has presented a timely paper on a subject that will be of interest to most mercury lamp users.

The statement is made that most mercury lamps have quartz arc tubes with very thin mily strips sealed in Vycor for electrical connections. As a matter of record, I would like to report that in all our lamps the original *Vycor* seal described in the Fraser-Till paper[1] was superseded by an *all-quartz* seal early in 1956, after several years' trial in several types. One advantage of the quartz press seal is that its inherently smaller mass and more favorable configuration permit the arc tube to warm up faster, for a given fill pressure.

The statement is made that to keep the lamp lighted requires as a rule of thumb an open circuit voltage equal to the arc tube rms voltage plus 45 volts. This is true for most lamps operated on typical high reactance ballasts. The voltage wave-form of the ballast has a marked effect, however. For instance, regulated output on constant wattage types can usually keep the lamp lighted when the secondary supply voltage is almost equal to the lamp operating voltage.

Mr. Harris' study of the ratio of yellow to blue light in various mercury lamps and at various burning hours shows what had long been realized by observation, namely, that there is hardly any significant color change among lamps by type or by age, excepting, of course, the normal color difference between mercury and fluorescent-mercury types. I would like to ask what kind of lamps were used to obtain the data for Fig. 8. Were the orthophosphate types found to hold relative color as well as fluorgermanate?

1. Fraser, H. D. and Till, W. S.: "Color Correction and Other Important Improvements in Mercury Lamps," Illuminating Engineering, Vol. XLVII, No. 4, pp. 207-213 (April 1952).

E. C. Martt:** This paper is the first publication of engineering data to determine the pressure of filling gas in the jacket. While much of the data is familiar to lamp design engineers, we expect it will interest users of mercury lamps.

In the discussion of Fig. 2, and in Fig. 2 itself, in which the duration of voltage drop is plotted against the magnitude of voltage drop required to extinguish the lamp, no mention is made of the "constant wattage" or regulator-type ballast. One of the important features of this type ballast is its ability to absorb large dips in primary voltage without extinguishing the lamps.

We believe there is an oversight in Fig. 4, which plots arc-over voltage versus outer jacket filling pressure. The breakdown voltage does not decline to a minimum at 0 mm pressure, as shown on the curve. In fact, the exact opposite is true, for if a perfect vacuum could be maintained in the jacket, the breakdown voltage would theoretically be infinite. Actually the pressure for easiest breakdown is a few millimeters. The practical objection to an evacuated jacket is the fact that a good vacuum cannot be maintained throughout lamp life. The jacket space usually becomes gassy due to evolution of gas from the jacket and other lamp parts. As a result of this evolution, the pressure for minimum breakdown is often obtained during lamp life, with disastrous results to the lamp. This is one of the reasons that our lamps have always been filled to a pressure of about one-half atmosphere.

On Fig. 6, we believe that the significant variable in determining the yellow to blue ratio is not the pressure in atmospheres, but is the quantity of mercury per unit length of arc for a given arc loading.[1] This quantity Elenbaas calls *m*, which is the measure of the number of mercury atoms in the arc stream. The yellow to blue ratio increases with arc loading and decreases as *m* increases. The pressure is not an important feature until its value becomes large.

In addition, our approximate calculations show that the H400-E1 operates at about 3.5 atmospheres compared to about 3 atmospheres for the H1000-A15. These values are reversed in Fig. 6.

1. Elenbaas, W.: "The High Pressure Mercury Vapour Discharge," North Holland Publishing Co., Amsterdam, 1951, page 115.

M. E. Robertson:* This paper represents a great amount of work and fills an important gap in this mystery of mercury lamp operation. I am indeed privileged to congratulate Mr. Harris.

*Westinghouse Electric Corp., Bloomfield, N. J.

**Large Lamp Dept., General Electric Co., Cleveland, Ohio.

*Commercial Engineer, Jefferson Electric Co., Bellwood, Ill.

I found the paper to be quite thought-provoking since many of the factors discussed have a very direct bearing on mercury transformer design and performance. For this reason I would like to ask several specific questions.

My first question is related to Fig. 1, Outer Jacket Fill Pressure *vs* Warm-Up Time. What type of ballast was used? By this I mean what was the open circuit voltage, and was the ballast a high-reactance or an auto-lag design? The type of ballast would affect the warm-up time, and perhaps Mr. Harris would like to comment on this. I realize that herein lies the basis for another complete paper.

My second question has to do with extinguishing characteristics as illustrated in Fig. 2. What fill pressures were used, and do the fill pressures affect the extinguishing voltages?

Question number three is about Fig. 3, Restrike Time versus Fill Pressure. Again, what open circuit voltage was used. I believe that the restrike time would be affected by the open circuit voltage of the ballast, and that it would be reduced as the open circuit voltage was increased. I would appreciate Mr. Harris' comments on this.

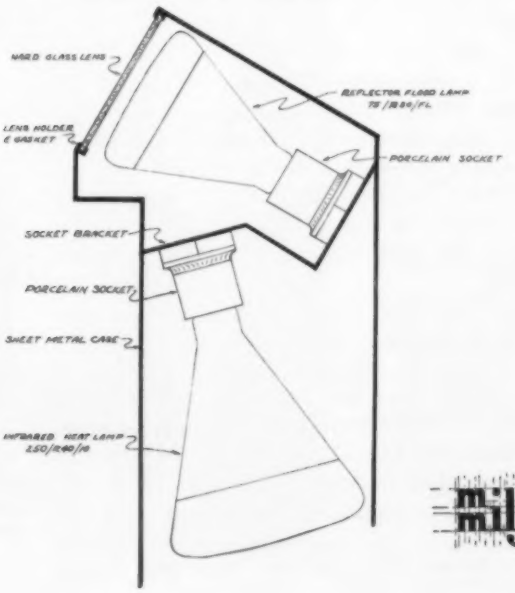
The fourth question is about arc over voltages as presented in Fig. 4. Mr. Harris arrived at 350 mm as the optimum outer jacket fill pressure. I would like to know if this pressure, and the arc over voltages shown would also be representative of lamps made by other manufacturers. If this is true then ballast open circuit voltages could be much higher than those in general use without damage to the lamp. It appears that voltages as high as 1800 volts rms or 2700 volts peak could be reached before the lamp would arc over. Ballast open circuit voltages of this order would hardly be practical, but voltages up to twice those now used would be safe, and in some cold weather applications practical.

I believe the author has made a real contribution in presenting this paper, since he has effectively added to our knowledge of mercury lamp performance. I am in favor of more such enlightening papers.

Milking Parlor Unit

Bulk milk cooling, pipe line milking, and milking parlors have created several problems for the dairy farm operator, one of them being illumination of the cow's udder, another the discomfort of the operator in cold weather. In an attempt to provide a practical solution to these two problems, a clamp-on unit combining a reflector flood and heat lamp was developed, using one 75w/R30/FL and one 250w/R40 heat lamp. The unit shown is a prototype and has been used with encouraging results. A further advantage of the arrangement has been ease of maintenance, and avoidance of the usual safety hazard experienced with floor-recessed units and smooth glass plate. Top photograph shows the unit in place on the edge of the milking parlor platform and shows its location in relation to the dairy animal. Note that the sloping face and top of the unit are designed to minimize collection of dirt and litter. Lower picture shows the operator in normal milking position, and shows the heat lamp warming his feet and legs. Drawing is a sectional view of the unit.

Lighting design is by George I. Craft, Wisconsin Electric Power Co., Kenosha, Wis. The installation won third prize in Milwaukee Section's contest for My Most Interesting Lighting Job.



Dental Lighting-
A Glimpse at Its History

By E. H. GREPPIN

THIS PAPER deals with the dental operating room only. Dental surgery carried on in a hospital should involve the use of standard surgical equipment.

Dentists today have the same difficult seeing task which complicated the work of their nineteenth century predecessors. Dentists of today face, because of improved and more exacting procedures, even more difficult problems than those of fifteen years ago — their task is much more difficult and exacting, hence more tiring.

Providing illumination for the requirements of precision dentistry has been a problem all through the years, particularly in view of the nature of the task: the necessity for getting light into the small space of the oral cavity and light from the right direction as well as in the proper quantity. Finally, although the dentist is interested in a very small visual field, it is desirable to illuminate the full oral cavity to lessen the possibility of contrast glare caused by uneven lighting in the immediate visual field. The oral cavity would be a dark hole if just a spot were lighted where the work was being done. Also the patient moves and the work area changes. A horizontally elongated spot is desirable.

It is obvious that unless very high levels, of the order of approximately 1,000 footcandles, can be projected directly into the mouth, where tissues and discolored teeth have a low reflectance, and the light strikes the work often at a poor angle to reflect back to the dentist, the effective illumination (light reflected back to the dentist's eye) will not approach the brightness required for precision dentistry.

In the "old days" a dentist was dependent upon daylight to illuminate this difficult task. There was great demand for offices which had large windows with northern exposures. Such exposures notwithstanding, however, daylight was no more constant then than now, Fig. 1, we may assume, and further, dropped off rapidly with the distance then as now, Fig. 2. Sometimes to supplement this, but more often to light offices at night, large lighting fixtures located in a position to direct light approximately along the dentist's line of vision, into the patient's mouth, became the general method for lighting dentists' offices during the nineties.

The early 1900's brought the next change in dental lighting practice. A four-light fixture was introduced and widely adopted as a special dental lighting unit, Fig. 3. While this offered some improvement over previous practice, the device did not project sufficient light. Small spotlights slightly larger than a flashlight were mounted on mobile arms to supplement it, and to illuminate the individual tooth being worked on. Glare by direct reflection or by contrast was the inevitable result.

Another development came in 1938 with the modification of a surgical operating room spotlight, which produced a horizontal beam of light to keep the light out of the patient's eyes and off of the white bib below the patient's chin, Fig. 4. Many modifications of this type of light have been made, most of these involving mechanical alterations and improvements. However, with the need for reasonably glare-free illumination, optical changes had to be made which would minimize the reflections from polished or specular surfaces, and at the same time produce adequate reflection of light back to the eye, even from the recesses of a cavity within a tooth.

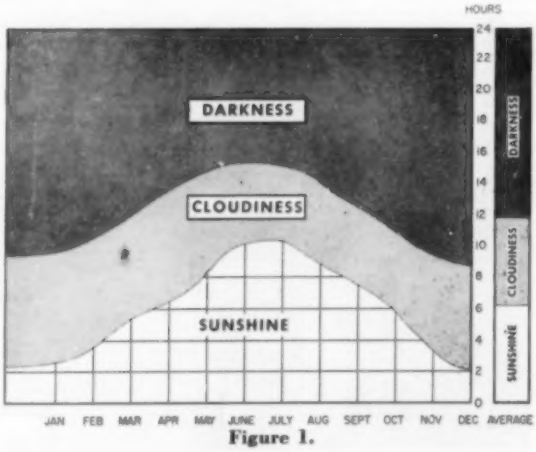


Figure 1.

AUTHOR: Manager, Light Department, Wilmot Castle Company, Rochester, New York.

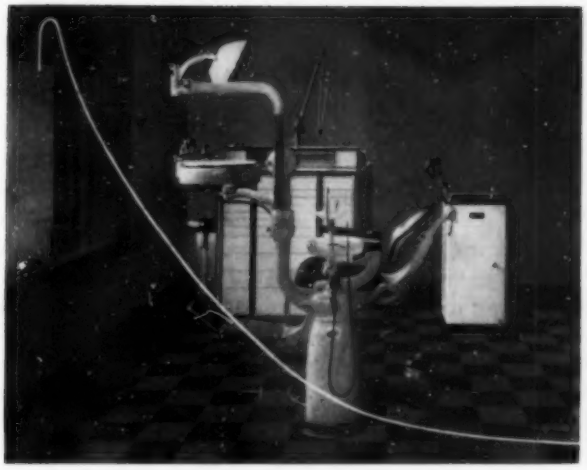


Figure 2.

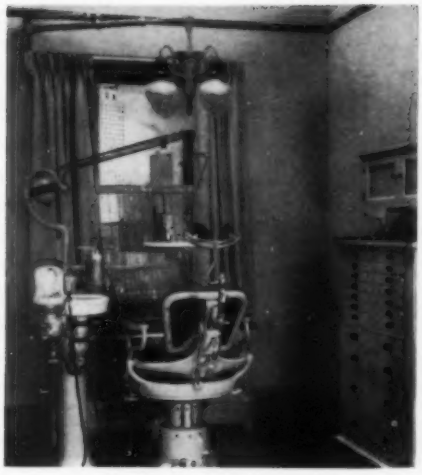


Figure 3.

With higher levels of light, it became necessary to absorb the infrared from the light beam. Glass normally available for that purpose had a characteristic greenish tinge, quite undesirable for dental work. To solve this problem, a special glass was developed which would absorb a large percentage of the infrared radiation and at the same time project a color of light which approximated sunlight (not sky light). Over the years this glass was improved to the point where its sufficiency and accuracy of color correction and heat absorption made it quite suitable even for color photography within the oral cavity.

When fluorescent lamps were first introduced, several attempts were made to build complete windows from a bank of lamps. This method of lighting was not generally adopted, for it simply made an improvement on the old "north window" idea by standardizing brightness and permitting a disregard to "sky view" location.

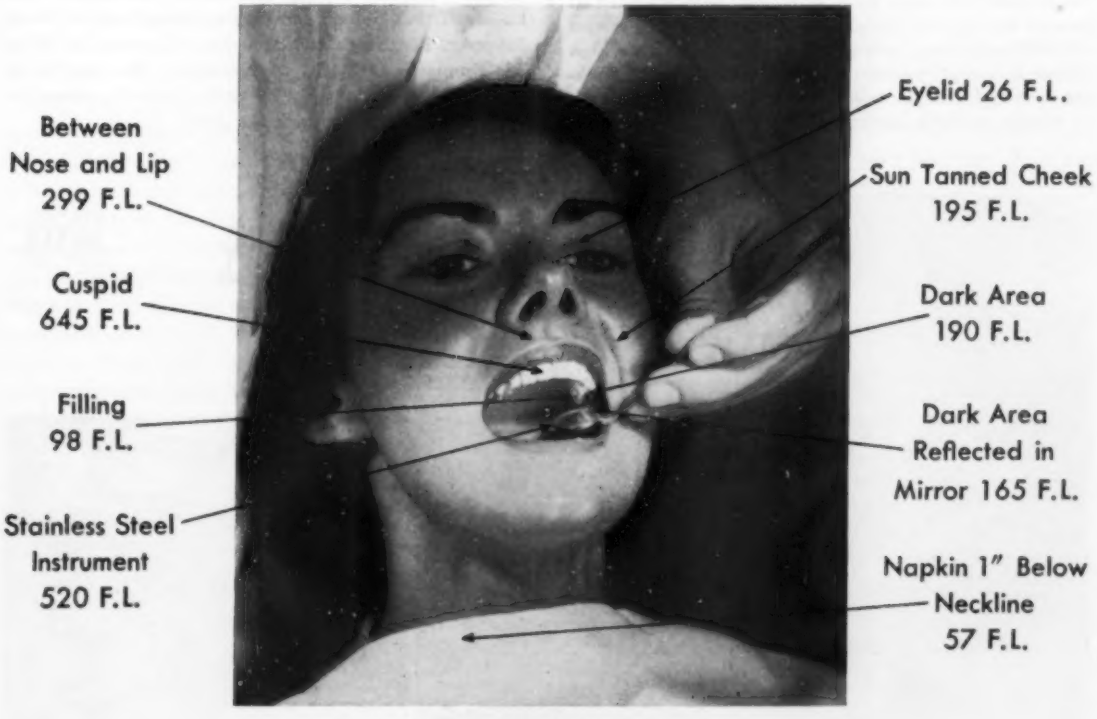


Figure 4.

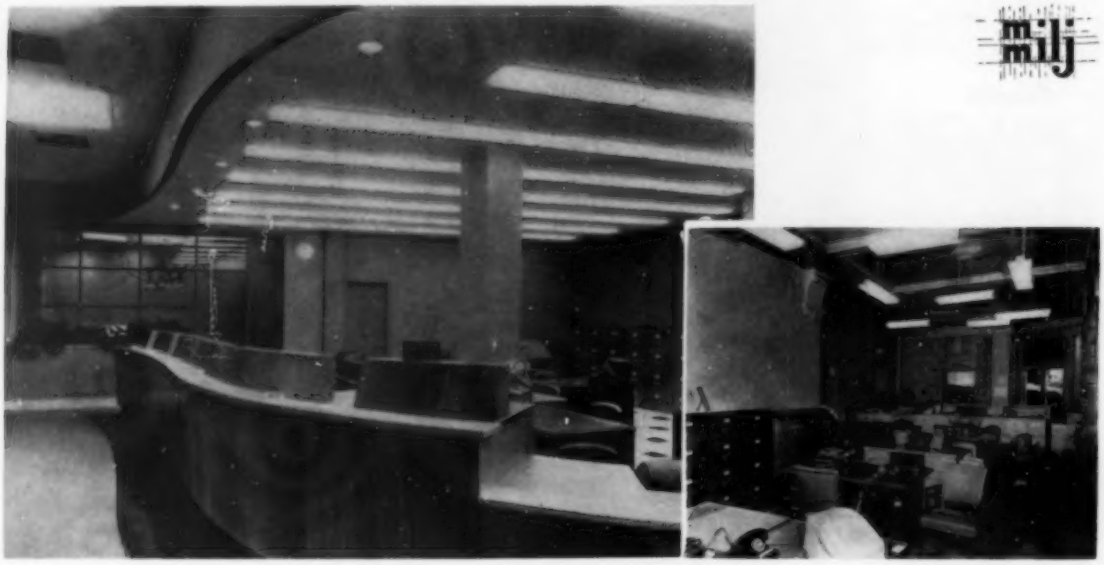
Naturally, suitable general room illumination had to accompany the higher level intra-oral lighting. When levels of the order of 1000 footcandles and brightness up to 500 to 600 footlamberts maximum were first introduced, it was anticipated that commercial luminaires of suitable types would be installed in dentists' offices. This was not borne out in practice, however, to any great extent. Dental supply companies now offer special lighting units particularly designed for use in the dental office which deliver illumination levels of 60 or more footcandles over the chair work area, with brightness ranging up to 500 or more footlamberts from bright surfaces and instruments in the work area. These levels are achieved with a minimum of shadow in the area immediately surrounding the dentist, especially the area where his eyes must constantly move to pick up or set down instruments.

One factor in contemporary dental lighting of considerable importance is the fact that dentists' operating rooms are becoming smaller and smaller as the cost per foot of office space goes up. The dentist is also doing a larger volume of work and more visually tiring work. Therefore, he must conserve his energy. This introduces the need for still greater adherence to lighting principles — the relation to proper balance of brightnesses between the very small visual field in which he works and his peripheral or background field.

Light and Architecture Rebuild a Bank

By crude statistics, the lighting levels in this bank before remodeling (see inset) would probably sound not unduly low. Obviously, however, much more than lamps, luminaires and wiring went into the new installation. Chief ingredients for its success were total adherence to I.E.S. lighting principles, and coordination of the individual abilities of the illuminating engineer, architect, contractor, interior decorator, and the manufacturers of paints, floor coverings, office equipment and furnishings. Careful attention to surface brightnesses and their ratios have, of course, been included as part of the lighting design. Very high levels, in excess of 100 footcandles, have thus been achieved with a high degree of visual comfort. Lighting system in the banking area and over the tellers working area features rows of 4-lamp recessed troffers, of 1 by 4-foot dimensions, on 4-foot centers. These units have drop acrylic plastic closures not entirely flush with the ceiling so that there is a desirable "splash" of diffused light on the ceiling itself. In the public area, 4-foot square recessed troffers, each with eight 40-watt rapid start lamps have been used. Supplementary lighting from six high-hat recessed units using 150-watt R-40 lamps, focus on the counter tops.

West End Federal Savings and Loan Association, Pittsburgh. Architect was W. L. Wurmb, Pittsburgh; contractor, T. P. Hanlon; and lighting design was by Murry Schutzer, Pittsburgh Reflector Co. (Chauncey B. Ross, Jr., Duquesne Light Co. cooperation). This installation won third prize in the Pittsburgh Section contest for "My Most Interesting Lighting Job."



Lighting Systems for Grading Lumber . . .

A detailed study of conditions encountered in sawmills; methods for lighting this critical industrial visual task.

By D. M. FINCH

THE LUMBER industry is one of the vital links in the economy of the West Coast, particularly the Northwest section. There are many facets to this industry including all of the problems of logging, hauling and processing of the lumber in the mills to obtain the various lumber products. One operation of the industry that is common to all phases is the problem of determining the quality of the product at various locations at which critical operations are performed. In these areas the vision of the workman is of vital importance. These particular sawmill operations involve the initial cutting, grading, selection, trim sawing and finish surfacing of the product. If the initial cutting and grading is not done properly much of the material may go into the lower grades and this means a great deal of money lost to the operators of the mill. If too many defects are permitted in the upper grades subsequent degrading will occur and more financial loss may be incurred.

Because of the seriousness of the grading problem a group of Northern California sawmill operators decided in 1952 to investigate some of the aspects of lighting and visibility in their mills. Prior to 1952 a small amount of lighting research was done on a local basis in various mills. The Hammond Lumber Company in particular did some very interesting work in California on lighting in grading areas. This caused substantial interest to be developed because it appeared that considerable improvement in grading efficiency could be obtained by devoting some attention to the lighting. Therefore, in 1952 a group of mill operators approached a few people in Northern California that might be interested in investigating this phase of their operation. Subsequently a working party was formed, including several mill operators and managers, utility engineers, lamp and lighting equipment manufacturers and University of California staff members including a Professor of Forestry, the Dean of the Optometry School and the author, a Lighting and Electrical Engineer.

The group started by looking into the conditions that existed at the time at mills in the Northern California area. After the first flurry of activity and a review of the survey work the Illuminating Engineering Society became interested in the West Coast work and appointed the group as a special subcommittee on sawmill lighting with instructions to proceed with the work under the general auspices of the I.E.S. (See page 381.)

The work began in earnest in 1952 with the Rounds & Kilpatrick Mill in Cloverdale, California as the focal point of operation. Mr. James Rhoda of the Rounds & Kilpatrick Lumber Company was most cooperative in setting up a field test program and in assisting the group in completing the investigation. The majority of the committee was not well informed on the details of sawmill operation, so it was decided to start by making a more complete survey of conditions in local mills. It was a surprise to find that lighting conditions in sawmills were so varied, and that they were in such an unsatisfactory condition. Ten mills were critically surveyed. Some of the results are indicated in Figs. 1, 2 and 3. These areas are all in the region of the initial grading location in the mills and are known as the *green chain* area.

Since there is such a variety of physical conditions in mills due to the size of lumber that is processed, the type of lumber and the end product that is manufactured we decided that one particular aspect of sawmill lighting, namely the green chain area would be the place to start. All of the mills have a green chain, and the green chain area is one of the first operations of primary importance from

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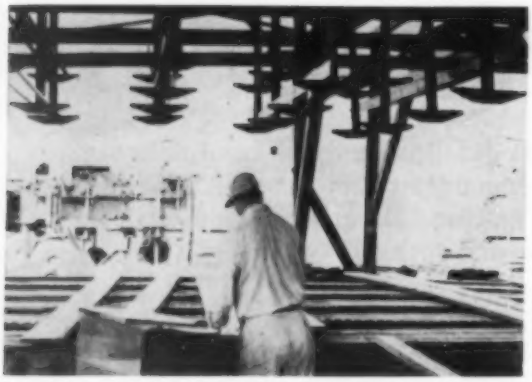

Figure 1. Typical poor lighting conditions found in sawmills (see also Figs. 2 and 3). Here, daylight grading, bright sky background.

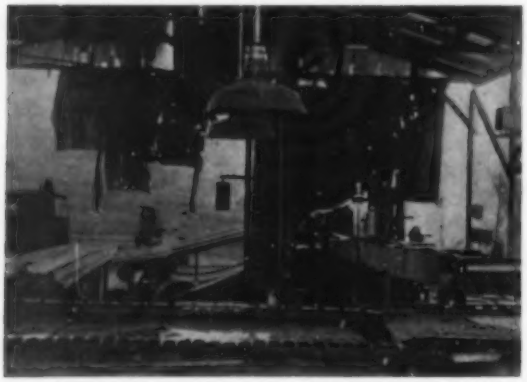

Figure 2. Minimum vertical illumination — dark surrounds.

Figure 3. Bare incandescent lamps — controlled background.

a visual point of view. At this location the rough sawn lumber is selected by graders and placed into categories of uppers (or the best quality), and commons (or lower quality). The commons may be modified and brought back through the operation for further grading to determine if they will then comply with the grading requirements for uppers. Thus the grader must decide whether or not the piece of lumber will meet the specifications for top quality, whether it should go into a re-saw operation, or whether it definitely has to go into the lower grade. The selection is critical, it requires very fast seeing, it requires the identification in a very short period of time of any number of possible defects of which there are about ten broad categories and at least 100 subgroups within the ten major classifications. Since this phase of sawmill lighting seemed so critical it was decided to limit our investigation to this area.

The size of boards to be examined varies with the mill, but usually boards up to 20 feet in length have to be inspected. The time available for seeing may be very short or long, but in most cases the boards are going by the observation point at a rate of about 25 to 30 feet per minute. Both sides have to be examined and therefore, within the time available the grader must look at one side, turn the board over, pass upon it, mark it and go on to the next. This requires considerable manual dexterity as well as good coordination and extremely good visual conditions. The detail to be perceived involves high acuity, *i.e.*, the seeing of small line type defects at large distances, as well as those requiring the distinction of contrast between two areas, such as the perception of stain and area type surface defects. The color of the wood and the defects, as well as the surface texture and pattern of grain are also important, although these may be of second order.

The visual environment in which the grading is done is extremely important but has received very little attention from the sawmill operators. Some grading is done out in the open in daylight, some in partially enclosed sheds, and some in completely enclosed sheds. The work may be under daytime conditions of bright sunlight, overcast sky or on swing or graveyard shift at night under completely artificial illumination. It is not surprising therefore that the quality of grading varies from day to day and from hour to hour.

The working party proceeded to define the problem in accordance with the above mentioned seeing requirements and to obtain samples of the defects that were representative. A very large group of samples was soon obtained. Since the evaluation of all of these would be a very time consuming job it was decided to restrict the investigation to redwood samples only. A total of 67 different and distinct defects in redwood were selected by graders in different mills as being representative of visual tasks that they were performing. Of the 67 samples we noted some that were similar and therefore, we

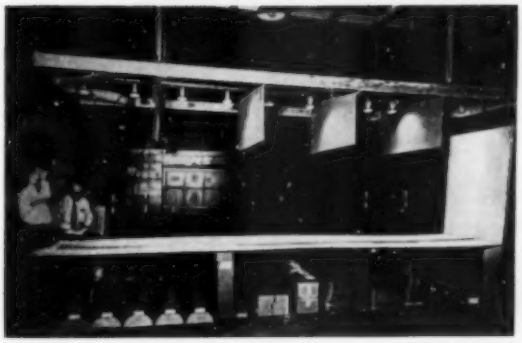

Figure 4. Laboratory set-up — general arrangement.

reduced the total number of samples used in our controlled laboratory studies to 41 out of the original 67. The list of samples and defects is shown with Figs. 7, 8 and 9.

The work of evaluating these samples under various lighting conditions was then set up as a research project in the Illumination Laboratory of the University of California at the Engineering Field Station, Richmond, California. The program was partially sponsored by the Pacific Gas and Electric Company, The California Redwood Association and the University of California.

The investigation consisted of two phases: the laboratory research and the field research. In the laboratory portion of the investigation an area was set up wherein we could simulate a 20-foot wide green chain lighted with various available commercial types of lighting equipment. See Figs. 4, 5 and 6. The visibility evaluations were actually made by two engineers who had been on the survey trip around the mills and had discussed the visual problems with the field graders. The defects were evaluated by means of the Luckiesh-Moss Visibility Meter which was the only practical visibility meter available at the time. The illumination and brightness measurements were made using conventional color corrected and angle corrected instruments.

The environment of the area was controlled so that we could have uniform or non-uniform brightnesses within the area. The direction of the lighting could be varied and the background brightnesses against which the defects were viewed could be changed.

The critical portion of a board for seeing defects is usually at the far end. Therefore, a situation was established wherein a reference board, 18 feet in length was placed on the simulated green chain with a 2-foot long sample containing the defect placed at the far end. The measurements were all made on the 2-foot long sample containing the defect, the balance of the area was set up get a typical brightness pattern. The lighting equipment varied from incandescent units which could be changed to get highly directional control or general diffuse illumination, to fluorescent lighting equipment which was either a lineal source or an area source depending upon whether or not diffusing panels were used on the luminaires. The lighting equipment was arranged so that it could be raised or lowered, or moved to one side for different dis-

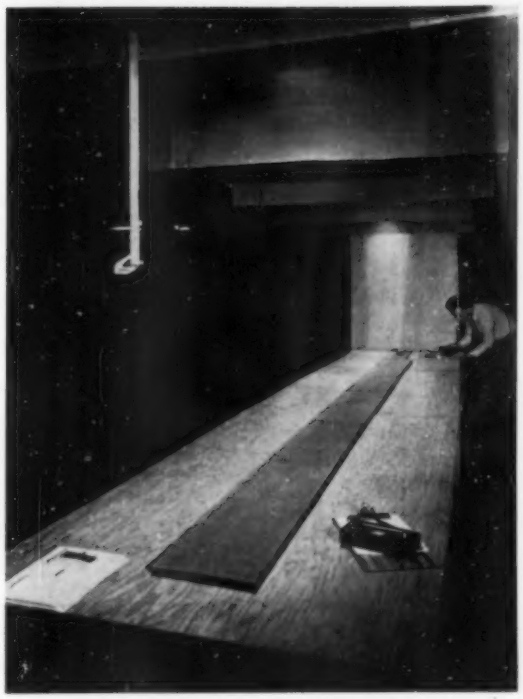

Figure 5. Simulated green chain — brightness and illumination measurements overhead incandescent lighting.

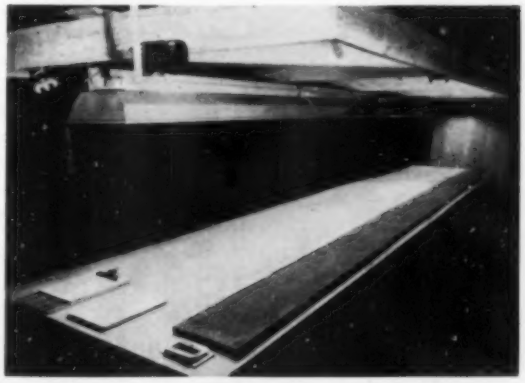

Figure 6. Laboratory set-up — fluorescent diffuse lighting.

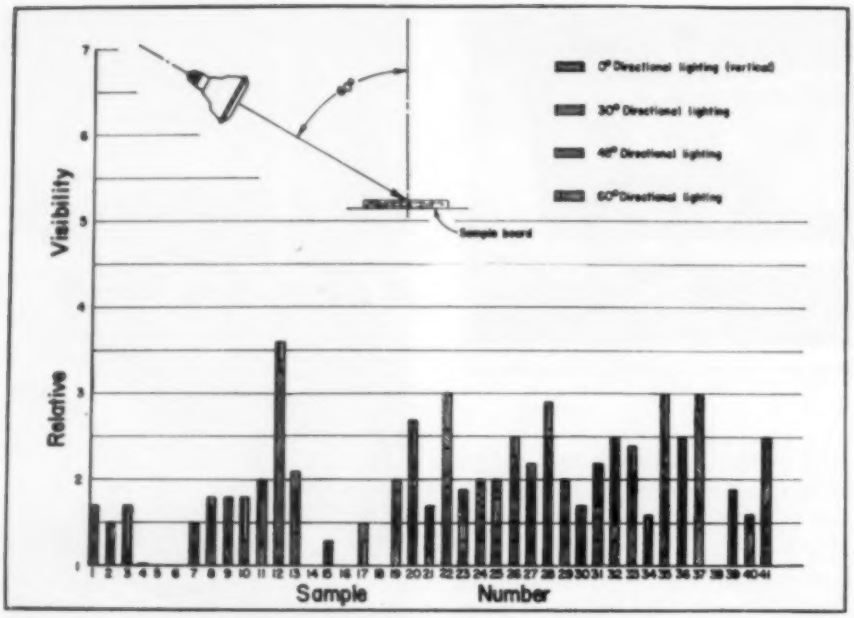

Figure 7. Incandescent directional lighting.

Defects

Sample No.	Description
1	Shake
2	Shake
3	Shake
4	Ring Shake
5	Shake
6	Shake
7	Split
8	Heart Shake (pith)
9	Corner Split
10	Ring Shake
11	Shake (with decay)
12	Season check
13	Split
14	Corner Split
15	Season Check
16	Split
17	Tight, unsound knot (1½ inches)
18	Tight, sound knot (4½ inches)
19	Worm holes
20	Tight, sound, spike knot (1 x 4 inches)
21	Tight, sound knot (2¼ inches)
22	Tight, sound knot (¾ inches)
23	Tight, sound knot (dark—easily mistaken for unsound) (3½ inches)
24	Tight, sound knot (1½ inches)
25	Cluster of small knots (3 x 1¾ inches)
26	Tight, intergrown knot (3 inches)
27	Tight, sound knot (surrounded by stain) (¼ x ¾ inches)
28	Unsound knot (1¼ inches)
29	Checked birdseye
30	Birdseye
31	End of burl (1½ x 4 inches)
32	Tight, sound, black knot (2½ inches)
33	Medium stain
34	Medium stain
35	Burn scar with medium stain
36	Medium stained shake
37	Fire scar
38	Fire scar
39	Worm holes
40	Bark wane
41	Handling damage

tributions of light in the visual area.

The field research portion of the program consisted of a series of installations and measurements in actual mills after the laboratory phase had been completed. Selected types of installations were placed in several mills on the green chain and graders used these installations for their regular grading. Records were kept of their performance under the new conditions. These were compared with the corresponding records which were obtained under the conditions of the prior lighting. Thus we were able to get statistical data on the change in performance under the new lighting conditions as well as subjective data from interviews with the graders regarding their personal preferences. The results of the research will now be discussed.

The effect of changing the distribution and direction of the light flux is revealed in the diagrams for both the incandescent and fluorescent lighting. Let us first examine the data for the incandescent units. Refer to Fig. 7. A series of experiments were made using most of the sample boards under identical levels of illumination, but with the lighting units

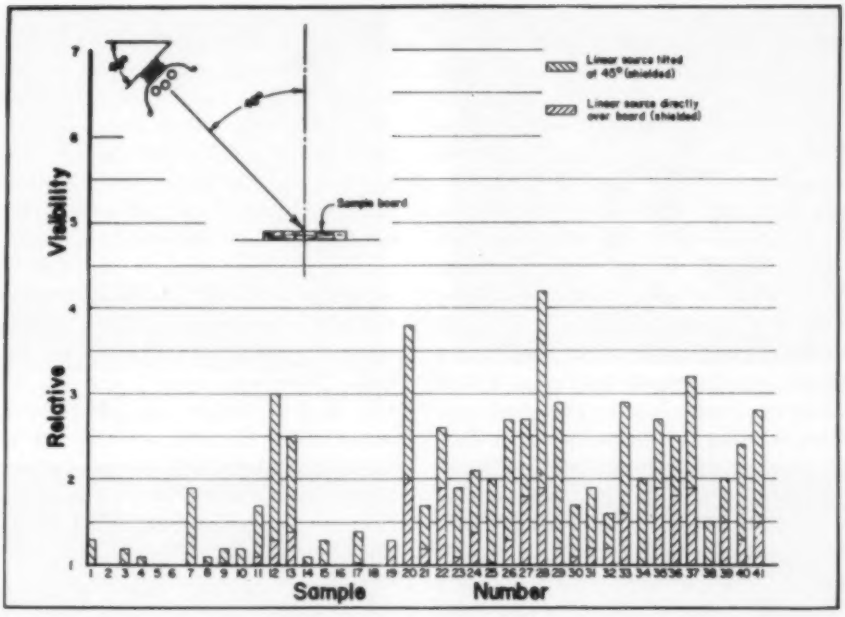

Figure 8. Fluorescent lighting.

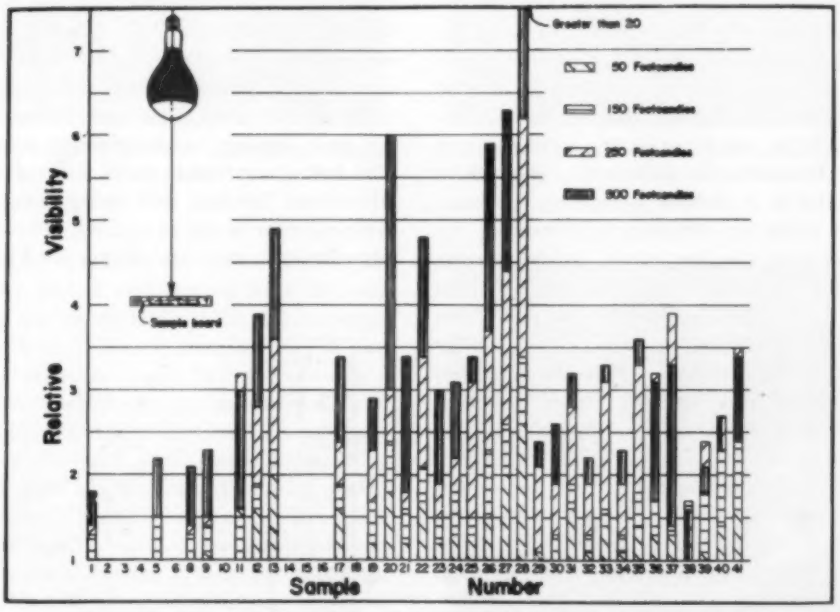

Figure 9. Effect of illumination level — overhead incandescent lighting.

mounted first directly overhead and then at varying angles of 30, 45 and 60 degrees to the perpendicular to the plane of the board. In practically all common types of defects light coming in at a high angle to the normal to the plane of the board is substantially better than vertical lighting. This is shown in Fig. 7 by the progressive visibility measurements when the lighting was changed from zero degrees to 60 degrees. You will not that for almost all types of defects an increase in visibility reading was obtained when the direction of the light was at a large angle. This was then further checked with

lineal fluorescent sources. The data on the lineal sources mounted directly overhead with line sources and then with diffusing panels underneath is not included here, but the data show that when the light is directly overhead, diffuse sources are somewhat better than line sources, indicating that it would be best to have a large area source rather than the single line source if overhead lighting only is to be used. The lineal sources mounted overhead or at an angle are shown in Fig. 8. An improvement is shown in visibility when the lineal sources are mounted parallel to the board and at an angle of approximately 45 degrees to the normal. Thus one can conclude that directional lighting at a high angle of 45 degrees or more is to be preferred over vertical lighting whether it is incandescent or fluorescent.

The level of illumination to use for optimum conditions was also investigated since this is an important factor from a standpoint of visibility as well as the initial cost and operation of the lighting system. A simplified system using incandescent sources directly overhead was used as a reference for evaluating the effect of changes in illumination level. Refer to Fig. 9. You will note that there is a progressive increase in the visibility for all of the defects as the illumination is increased from 50 to 100 footcandles. For further increases up to 250 and 500 footcandles, one can observe that an increase in visibility continues as the lighting level is increased but for some defects the gain above 250 footcandles is a smaller percentage increase. The greatest gains are obtained in increasing the lighting level from the low values of illumination up to the order of 250 footcandles. If one is able to obtain the higher lighting levels up to and above 500 footcandles, continued increases in visibility will be obtained, but these will not be the same percentage increases as those that are obtained in changing from 50 to 100 footcandles. Therefore, the first step to consider in improving lighting in the grading area is to get to at least 100 footcandles of proper quality illumination on the grading table. From there on the lighting design will be one of refinement to get additional and important gains in grader performance.

The overall lighting in the grading area is also quite important. This general lighting should provide the background brightnesses that are used by the grader to establish the environment against which he is attempting to see the defects. The green chain grading problem is typical of many industrial seeing tasks in which critical detail have to be seen quickly and accurately. All laboratory researches that have been made to date on visual performance show that best seeing conditions are obtained if the background against which the critical vision is being performed is approximately uniform in brightness and equal to or slightly less bright than the area of critical seeing. In almost all of the mills visited including those that have been shown in Figs. 1, 2 and 3 attention to the brightness of the environment has been almost nil. In our laboratory studies we were careful to provide an approximately uniform background brightness against which our visibility measurements were made. A few trial runs were made in which the background was dark and some were made in which the background was much brighter than the task. These were made to simulate both the nighttime and the bright daylight conditions found in actual mills. In both cases it was very apparent that the background influenced the visibility and that our original conclusion was correct.

It was concluded from the laboratory studies that the directional lighting was important, the amount of illumination was important and the environmental brightness conditions in which the grader is operating were important. We next proceeded to make trial installations in several mills. As usual in such situations, the mills had to remain in continuous operation and the amount of equipment and materials available for the experimental work was limited. Therefore, the trial installations were not made in a complete and comprehensive way, but each lighting design principle was checked out. The first phase was to build a cheap but practical directional lighting unit using incandescent 300-watt reflector lamps as sources. The details of the experimental unit are shown in Fig. 10. These

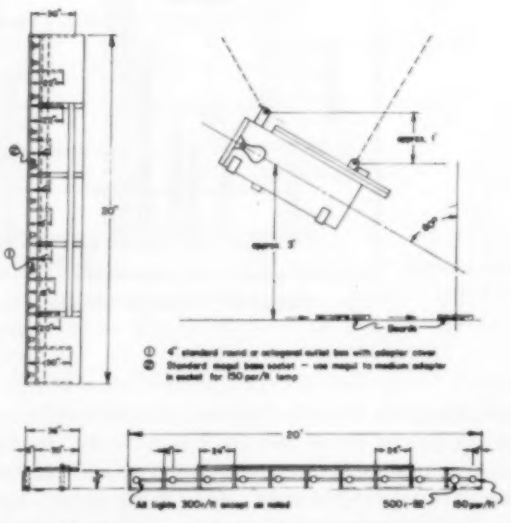

Figure 10. Experimental incandescent lighting unit used in grading tests on the green chain and siding chain.

Figure 11. Directional incandescent grading lighting unit.

Figure 12. Incandescent grading light.

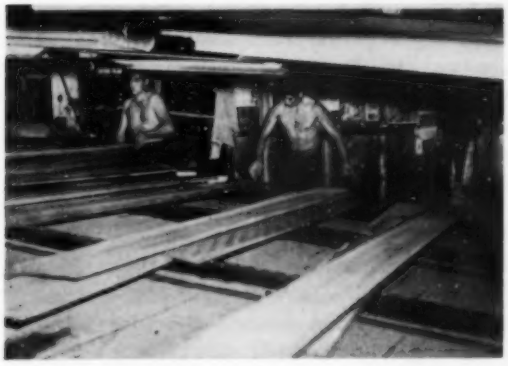

Figure 13. Fluorescent luminaires mounted parallel to flow — units tilted slightly away from grader.

Figure 14. Fluorescent luminaires mounted transverse to flow. Note extra shielded unit used for background lighting.

lamps are readily available and materials for the construction of such a unit are on hand in every mill area. Local maintenance men can assemble and maintain such a simple installation. In this case 300-watt reflector lamps are mounted in a shielded enclosure which can be suspended on pulleys or wires above the grading area. The angle of incidence on to the work plane can be adjusted by changing the wire suspensions. The unit shown was mounted over a grading table at the Rounds & Kilpatrick mill and the graders used this particular installation for a number of months. See Figs. 11 and 12. This mill is one in which we expected to obtain only a small gain in grading efficiency because initially the mill had about 70 footcandles of general diffused lighting over the grading table. However, even in this case the graders' reactions to the installation were favorable and the records of grading performance showed appreciable improvement following the directional lighting installations. In one instance the grading efficiency increased from 81 per cent to 90 per cent after the change in lighting.

Figure 15. Fluorescent luminaires parallel to flow from grader's position.

Other mills had fluorescent units available at no cost so these were mounted over the grading table in the green chain area in various combinations to determine their effectiveness. Figs. 13, 14 and 15 show some of these trial installations. In some

cases the units were mounted lengthwise in the direction of the flow and tilted slightly away from the grader. See Fig. 13. In other cases the units were mounted transverse to the flow (parallel to the boards). See Fig. 14. The general grader reaction seems to be that the lights mounted transverse to the direction of flow (parallel to the boards) are superior because the brightness pattern on the board is more uniform and therefore the general appearance of the board has better continuity and defects that run with the grain are more easily detected. The lighting units that are shown were all mounted directly overhead with their maximum intensity normal to the board. This is a reasonable practical method of installation but has secondary preference to directional lighting insofar as our laboratory studies indicate. However, overhead vertical distribution will still substantially improve the visual conditions and will make the grading more efficient because it will provide higher levels of illumination than normally exist. Even though the directional effect is not obtained the benefits of higher levels of illumination will be apparent.

The graders in some instances indicated a preference for fluorescent lighting over incandescent lighting. Such a statement should not be made as a general conclusion but it was quite positive in some instances and possibly was due to the temperature effect of the incandescent lamp radiation when the grading was done under extremely warm summer conditions. See Fig. 13. The fluorescent installation is notably cooler than the incandescent installation. There is also some color effect particularly on defects such as stains. The contrasting color obtained with fluorescent light on redwood makes stain more evident. This effect has not been carefully evaluated and the mill operators indicated that the detection of stain is not of major economic significance in redwood grading. Therefore, we have concluded that the color of the grading light is a secondary order variable although under certain circumstances it may be quite important.

The comfort aspect of the lighting in the grading area is also extremely important. Due to the critical nature of the seeing task which involves sustained high speed viewing, the fatigue of the grader can influence his judgment to a large degree. The lighting needs to be such that the area in which the critical task is being viewed is of high enough brightness to key the grader to the task. The distribution of light should be in such a direction as to make the defects more readily seen. The brightness of the environment in which the grading is being done should be of the same order of magnitude of brightness as the task. Furthermore, all of the high brightnesses of the light sources should be entirely shielded from the grader's view. Attention to these basic principles of lighting will permit substantial improvements in grading accuracy as is evidenced by the field studies in which improvements in grading efficiency as much as ten per cent can be obtained by changes in lighting.

This report covers the lighting in one particular area in a sawmill, *viz.*, the green chain. Other areas, while not the same in detail, have many degrees of similarity and the basic visual concepts that have been discussed are common to many industrial seeing tasks. The solution of other visual problems will revolve around the treatment of each local area in accordance with the specific requirements determined from a detailed analysis of the seeing task. The solution to each individual problem will be slightly different but the above concepts will apply. In each case one should provide general lighting in the whole area which is adequate to develop the required background brightnesses for proper visual adaptation and then treat each local area with substantially increased amounts of well controlled lighting. The *general* lighting is important but it cannot be expected to do the whole job in each particular situation.

In our studies the above basic formula for lighting has been confirmed. Laboratory studies have been used to develop data on the specific visual task and field studies have been made which support the laboratory findings. We recommend the use of these data as contained in the report of the Sawmill Lighting Committee of the Illuminating Engineering Society as an aid in improving the performance of the graders on the green chain.

The official I.E.S. technical committee report "Lighting for Sawmills: Redwood Green Chain," prepared by the Subcommittee on Sawmill Lighting, appears on page 381 of this issue.

Lighting for Sawmills: Redwood Green Chain

Prepared by the Subcommittee on Sawmill Lighting of the Industrial Committee of the Illuminating Engineering Society

FOREWORD

In June of 1952 the Rounds-Kilpatrick Company of Cloverdale, California, requested detailed specifications for lighting of redwood mills, and in particular, the amount of light required for grading areas. This resulted in the study reported here.

It is hoped that this investigation, besides citing one or two examples of lighting for redwood green chain inspection, will point the way for further research so that a set of standard practices for the lighting of lumber mills may be developed.

Two members of the Subcommittee were sent to the Rounds-Kilpatrick plant for a period of a week to obtain essential data on the factors involved in the grading of redwood lumber. The purpose of this trip was to initiate a preliminary investigation and obtain as much data as was necessary to arrive at a satisfactory solution. Part of the time was spent in investigating the lighting conditions existing in eight other mills in the general area. In contacts with supervisory personnel at these mills, a general dissatisfaction with the lighting and a recognition for the need of set recommended practices was found. It was determined that the green chain grading table presented some of the more severe visual tasks and the need for proper illumination was greater in this area.

After a preliminary study comparing the effects of directional and diffused lighting upon the visibility of various types of defects, several experimental installations were set up in typical mills. Care was taken to use standard equipment readily available to mill operators or construction of which could be handled by mill employees. In the course of the study it became apparent that psychological problems of change, education and adaptation to something new are also important factors.

The Subcommittee wishes to thank the University of California for the use of the lighting testing laboratory at the Richmond Field Station; the Benjamin Electric Manufacturing Company and the General Electric Company for lighting equipment and lamps used in the study; Selwyn J. Sharp, Secretary, California Redwood Association, in charge of inspection and grading section; Louis Ehling, Assistant to Mr. Sharp; Willard E. Pratt, Research Director, California Redwood Association; George Nelson, Chief Inspector, California Redwood Association; Ralph Talvola, Assistant to Mr. Nelson; John Rhoda, Manager of the Rounds-Kilpatrick plant; and Glen Hesseltine, Chief Plant Inspector.

The Subcommittee also wishes to acknowledge studies carried out in this field by Lloyd M. Snook, Electrical Engineer, Hammond Lumber Company; A. F. Pongracz, Industrial Engineer, Western Pine Association; and S. Hazelton, Engineer, Lamp Division, General Electric Company.

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Approved by the Council of the Illuminating Engineering Society, September 1956.

1. Purpose

It was the main purpose of this preliminary study to determine the quality of light required for redwood green chain lumber grading. A further purpose of this preliminary investigation is to stimulate interest and to point the way for further research so that a set of standard practices for the lighting of lumber mills may be developed.

2. Sequence of Processes

Fig. 1 outlines the typical processes occurring in redwood remanufacturing plant operation. This report deals with the green chain grading process. As shown in Fig. 2, the grader stands at one side of a series of conveyor chains and looks down the length of boards which may measure as long as 20 feet.

3. Summary of Findings

3.1—*General*— (a) Results of visibility tests described later in this report were generally substantiated by field testing.

(b) For most satisfactory results no matter what type of lighting is used, it was observed to be important to provide light over the full length of the longest board which might be graded on the chain.

(c) In no case should the bright surfaces of lighting units or of a bare lamp be left exposed to the grader's eyes.

3.2—*Directional Lighting*— (a) It appeared that directional lighting produced the best results in increasing the visibility of shakes, checks, splits and knots.

(b) It appears from observations made in the laboratory and in the field that the lighting units should be mounted in rows parallel to the length

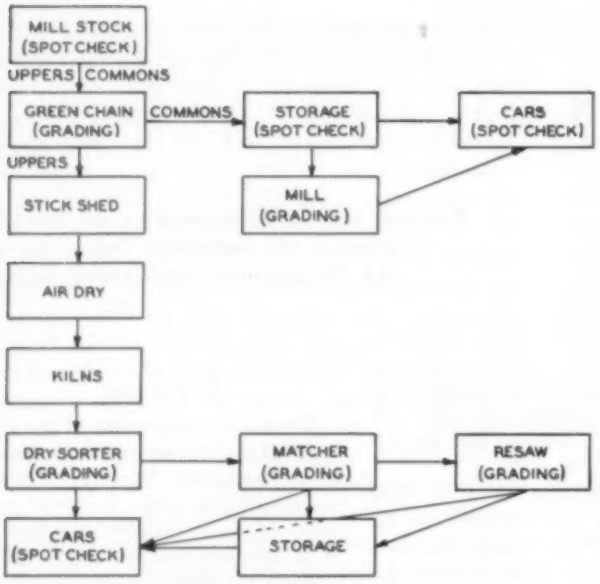


Figure 1. (Left). Typical processes.

Figure 2. (Below). Grader.

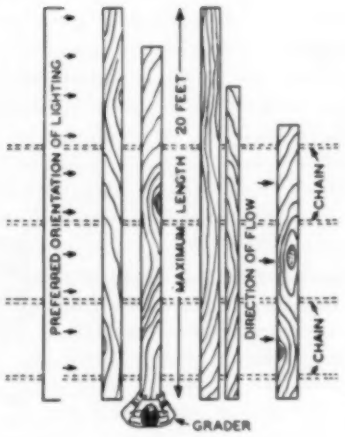


Figure 3. Mounting frame and table. Luckiesh-Moss Visibility Meter being mounted. Sample board at opposite end of table.

Figure 4. Luckiesh-Moss Visibility Meter.

Figure 5. Baumgartner Reflectometer used to measure total reflectance of redwood samples.

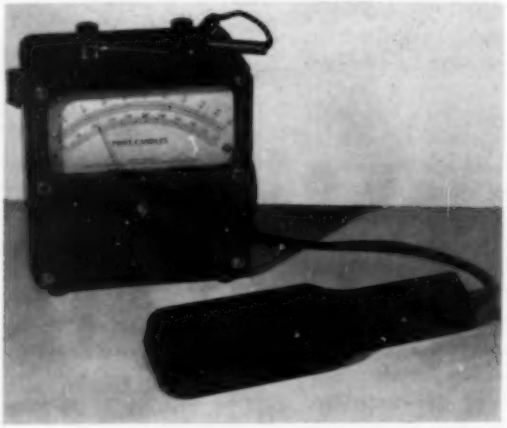


Figure 6. Light meter used to check footcandle level on sample boards under various laboratory lighting tests.

of the board and tilted to project the light at a fairly sharp angle, in the direction of flow of the board.

(c) In the experimental set-up incandescent reflector lamps were used with specially constructed shielding as shown in Fig. 13.

(d) Fig. 13c shows commercially available units (both filament and fluorescent types) which will perform similarly. Dust-tight equipment is recommended.

3.3—*Diffuse Lighting*— (a) Diffuse lighting (non-directional) was found to be generally satisfactory for grading tables, as a second choice.

(b) Existing fluorescent equipment in mills may be adapted with diffusing panels so as to give improved results.

(c) Consideration should be given to the use of good dust-tight fluorescent units with proper diffusion characteristics.

3.4—*Illumination Level*— Test data were taken at 50, 100, 250 and 500 footcandles. From these data and from field observation it appears that lighting levels of 100 footcandles or more are needed for the grading of redwood lumber.

3.5—*Color*— The effect of color on the grading of redwood was not evaluated under controlled conditions in these tests. Comments on the graders' appraisal of color are included in Section 8 of this report.

3.6—*Environment*— Field conditions emphasized the need for shielding the glare from bright sky areas by enclosing the grading area. Painting of background areas was also strongly indicated. A flat gray with a reflectance of 45 per cent was used for test purposes.

4. Analysis of Seeing Problems

4.1—*General Description*— As shown in Fig. 2, the grader views twenty feet of board moving along past him on a conveyor. The chain in the mill used in this study traveled 25 to 30 feet per minute, and the boards were usually spaced two inches to two feet apart. Both the speed of the chain and spacing of the lumber vary a great deal from mill to mill. The grading is based on the defects in boards.

4.2—*Defects*— (a) A defect is defined as any irregularity on or in lumber that may lower some of its strength, durability or utility values.

Figure 7. Observer making visibility measurements on sample board using zero degree directional lighting.

Figure 8. Line source off center of board 45 degrees and tilted. Note: Camera was not at position of grader's eyes. In normal viewing position bright surfaces of luminaires are not visible.

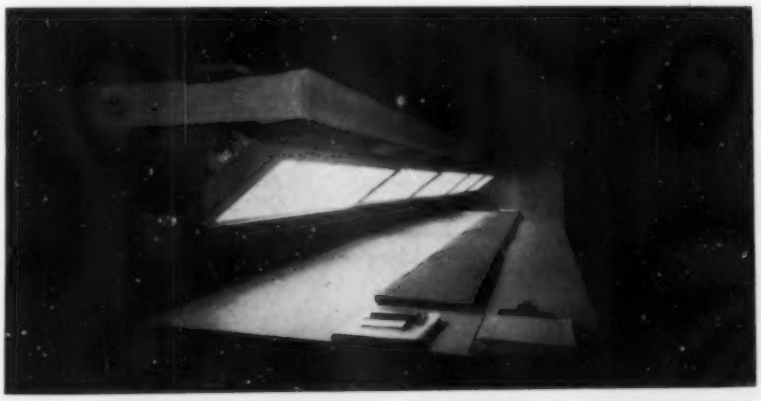


Figure 9. Diffuse surface source off center of board 45 degrees and tilted. Note: Camera was not at position of grader's eyes. In normal viewing position bright surfaces of luminaires are not visible.

Figure 10. Equipment set up to determine effects of amount of illumination on relative visibility of redwood defects.

Figure 11. Before photograph of area where experimental directional lighting was installed.

Figure 12. Experimental directional lighting.

Some characteristics which are considered defects in certain grades or for certain uses do not lower the value in other grades or for other uses and may actually increase its value for such uses. The commonly recognized defects in California Redwood lumber are described below.

(b) *Bird's eye* is a small central spot with the wood fibers arranged around it in the form of an ellipse, so as to give the appearance of an eye. Bird's-eye, unless open or checked, is not considered a defect. When the term is used in description of a piece of lumber, the meaning is plural.

(c) A *check* is a lengthwise separation of the wood, which occurs usually across the rings of annual growth. A *surface check* is a check appearing on the surface of the piece. A *small surface check* is a perceptible opening not over four inches long. A *medium surface check* is one over $\frac{1}{8}$ inch wide or over four inches long.

(d) *Holes* in wood may extend partially or entirely through the piece and be from any cause. When holes are permitted, the average of the maximum and minimum diameters measured at right angles to the direction of the hole shall be used in measuring the size, unless otherwise stated.

(e) The average of the maximum and minimum diameters is used in measuring the size of knots, unless otherwise stated.

Pin knot is one not over $\frac{1}{2}$ inch in diameter.

Small knot is one over $\frac{1}{2}$ inch but not more than $\frac{3}{4}$ inch in diameter.

Medium knot is one over $\frac{3}{4}$ inch but not more than $1\frac{1}{2}$ inches in diameter.

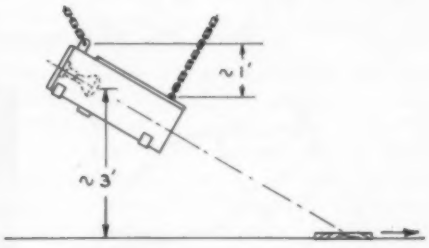
Sound knot, irrespective of color, is as hard as the wood it is in, and so fixed by growth or position that it will retain its place in the piece.

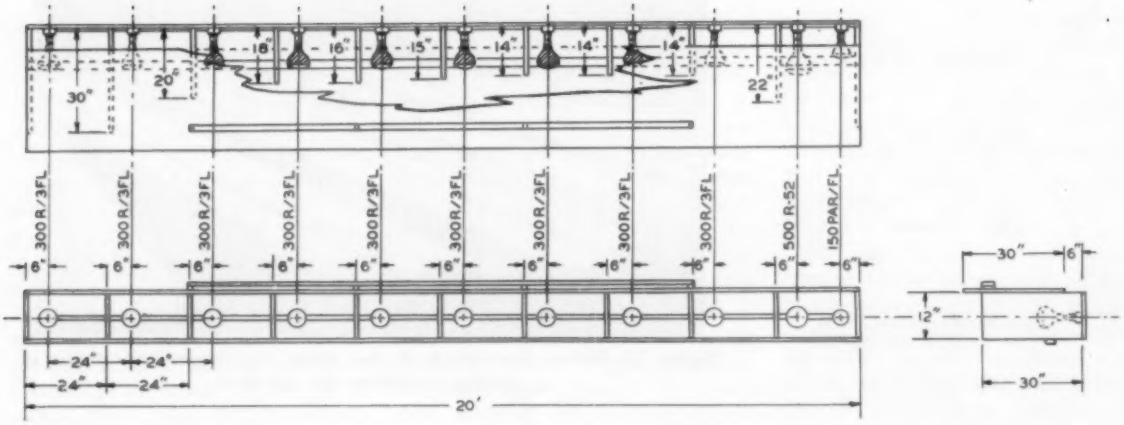
Unsound knot is not as hard as the wood it is in.

Decayed knot is softer than the surrounding wood and contains advanced decay.

Tight knot is one so fixed by growth or position that it will retain its place in the piece.

Figure 13a. Perspective view of inspector and boards (left). Below, diagrammatical sketch of experimental lighting unit.





Intergrown knot is one whose rings of annual growth are completely intergrown with those of the surrounding wood on at least one face.

Watertight knot is one whose rings of annual growth are completely intergrown with those of the surrounding wood on at least one surface of the piece, and which is sound on that surface.

Loose knot is one not held firmly in place by growth or position and may or may not remain in place in the board.

Pith knot is a sound knot with a pith hole not more than ¼ inch in diameter.

Hollow knot is an apparently sound knot with a relatively large hole in it.

Knot cluster is two or more knots grouped together as a unit with the fibers of the wood deflected around the entire unit. A group of single knots is not a knot cluster. Knots shall be considered as being grouped when two or more knots are closer than twice the sum of their least diameters.

Corner knot is a knot which extends through the corner of the piece and is not entirely surrounded with wood.

(f) A *shake* is a lengthwise separation of the wood, which occurs usually between and parallel to the rings of annual growth. A *fine shake* is one with a barely perceptible opening. A *slight shake* is one with more than a perceptible opening but not over 1/32 inch in width.

(g) A *split* is a lengthwise separation of the wood due to the tearing apart of the wood cells.

(h) *Stain* is a discoloration, occurring on or in lumber, of any color other than the natural color of the piece on which it appears. It is classified as light or medium, and is not considered as decay.

Light stain is a slight difference in color which will not materially impair the appearance of the piece if given a natural finish. Light stain is not considered a defect in any of the grades provided for and described in these rules.

Medium stain is a difference in color which although it does not obscure the grain of the wood, would customarily be objectionable in a natural but not a painted finish.

(i) *Wane* is bark, or the lack of wood or bark, from any cause, on the edge or corner of a piece.

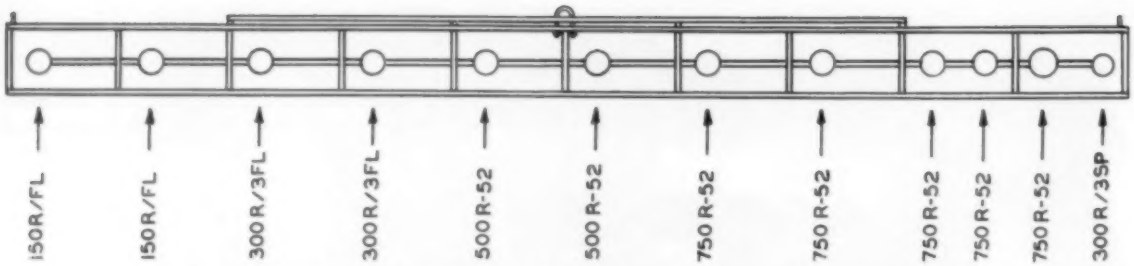


Figure 13b. Alternate arrangement of lamps for higher intensity grading light.

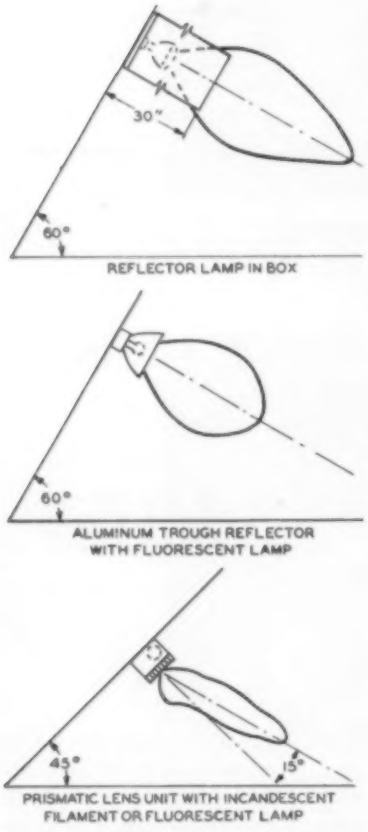


Figure 13c. Commercially available directional lighting equipment suitable for lighting redwood green chain grading.

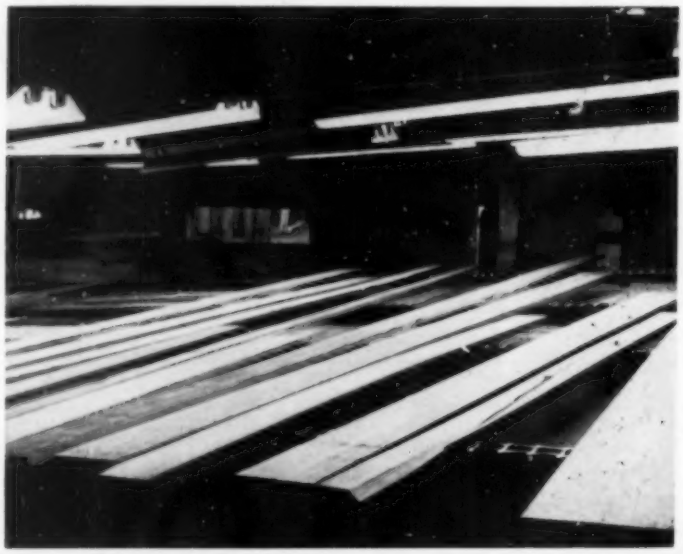


Figure 14. Before photograph of area where experimental adaptation of existing equipment was installed.

5. Experimental Procedure

5.1—*Test Equipment*— A mounting frame was constructed and suspended over a 20-foot table by means of block and tackle from the rafters of the dark room of the lighting testing laboratory. Using this frame and the lighting equipment provided, a study was made of the effects of different types of lighting on the various redwood defects with a Luckiesh-Moss Visibility Meter.

Figure 15. Experimental adaptation of existing equipment.

5.2—*Sample Boards* — The 67 sample boards which were selected at the mill by graders, and inspectors, as well as the mill manager, were considered to be representative of the graders' seeing tasks. These sample boards were further checked, classified, and approved by four staff members of the California Redwood Association. Sample boards numbers one through 19 consist of examples of shake, check and split. Sample boards numbers 20 through 41 consist of knots of various types. Samples 42 through 53 consist of stains, and samples 54 through 67 consist of miscellaneous scars, worm holes, wane and manufacturing imperfections. Photographs of the sample boards are included in the Appendix.

5.3—*Procedure* — The sample boards were placed at the far end of the 20-foot table approximating the actual grading conditions as far as possible, except that the sample boards were kept stationary instead of in motion as on the grading chain. The Luckiesh-Moss Visibility Meter was rigidly mounted at the opposite end of the table in the normal position of the grader's eyes while grading. At least 15 consecutive readings were taken on each board under 22 different lighting arrangements. For every eight sets of readings, a set of calibration readings was taken on a specially prepared parallel bar test object. Each set of 15 readings was averaged and corrected as indicated by readings on the parallel bar test object. Directional, uniform diffuse, non-uniform diffuse and line sources types of lighting were studied and each case was rated in terms of relative visibility with each other by means of available meters.

6. Test Results

Tables I to III show the data obtained in the laboratory for directional lighting, a line source, and a diffuse source. Table IV shows the effect of level of illumination on the visibility of 41 samples.

7. Trial Installation

7.1—*Directional Lighting* — **(a)** In order to correlate the directional lighting data collected on stationary boards in the laboratory to the moving boards in the mill, a redwood box was constructed to provide shielding and a mounting board for eleven reflector lamps. The size and spacing of the lamps were arranged to give directional lighting at an angle of 60 degrees to the normal with an average of 100 footcandles on a 20-foot board. Larger lamps and closer spacings were provided at the far end of the light box in order to build up the light levels on the far end of the board. The outside of the box was painted a flat gray with a reflectance of 45 per cent. The box was then suspended about three feet above the green chain grading table. A diagram of the equipment used is shown in Fig. 13a. Fig. 13b shows an arrangement for higher wattage.

(b) This directional incandescent lighting unit was also tested on finished siding where the seeing problems are different due to the different character of lumber involved. It also met with approval there.

7.2—*Diffuse Lighting* — An attempt was also made to adapt existing fluorescent equipment in a mill to provide the same conditions that were obtained in the laboratory. The possibility of obtaining a directional effect was investigated and was found not to be practical with the available equipment. The next best solution for utilizing existing equipment was to use diffused light. The equipment used in testing this conclusion consisted of standard two-lamp 90-watt, industrial, fluorescent units. Four of these units were mounted end to end. Metal brackets were made up in the mill and fastened to the bottom edges of the reflectors in which sheets of acrylic plastic* 12 x 60 x 0.125 inches were placed. This 20-foot unit was then suspended approximately three feet over the green chain parallel to the boards and perpendicular to the direction of flow. Four of these 20-foot units were used, spaced four feet apart.

7.3—*Environment* — The management in the mills where this lighting was tested was aware of the problems of glare from high sky brightness and had closed in the areas around the graders. The walls, however, had not been painted. The painting was therefore included in the test. A commercially available flat gray paint of 45 per cent reflectance was obtained and applied to the walls. The improvement in the ease of seeing and carrying out the task of grading was immediately noticed by all.

*No. 2333 - 150, Plexiglas.

8. Results of Trial Installation

8.1—*Directional Lighting* — **(a)** It took the graders a day or two to become accustomed to the shadows produced on the boards by the directional lighting as the boards were turned. However, they soon learned to turn the boards so that they could use the lighting to best advantage. After the lighting had been used for a while, all agreed that it made detection of defects easier.

(b) The graders in the mill where this lighting was tested were accustomed to working under fairly high levels of fluorescent lighting, and the difference in color between the incandescent and fluorescent lighting did produce some minor problems. The study was limited to redwood with its predominantly red color.

(c) The color differences produced by the standard cool white and white fluorescent lamps were preferred by the graders as an aid in detecting stain and sapwood; however, management in the mill felt that color differences had been over-emphasized and they preferred the overall results produced under the incandescent lamps.

(d) This directional incandescent lighting unit appeared to be of even greater value when used in the grading of finished siding. The graders working where the unit was tested commented that it was the best lighting they had worked under, making it considerably easier to see the defects that they had had most trouble with.

8.2—*Diffuse Lighting* — **(a)** The graders working on the green chain where the experimental adaptation of existing fluorescent equipment was made were accustomed to working under fluorescent lighting and found no difficulties in adjusting to this system. They appeared to be more satisfied with this lighting than with any they had worked under.

(b) The principal problem encountered was one of maintenance. The great quantities of sawdust in the air quickly collected on the upper surface of the plastic greatly reducing the light reaching the board. Therefore, dust-tight units with proper diffusion characteristics as well as fairly high resistance to breakage are recommended.

8.3—*Controlled Test of Effectiveness of Directional Lighting* — **(a)** The accuracy of one of the graders working on finished siding was

(*Continued on page 392*)

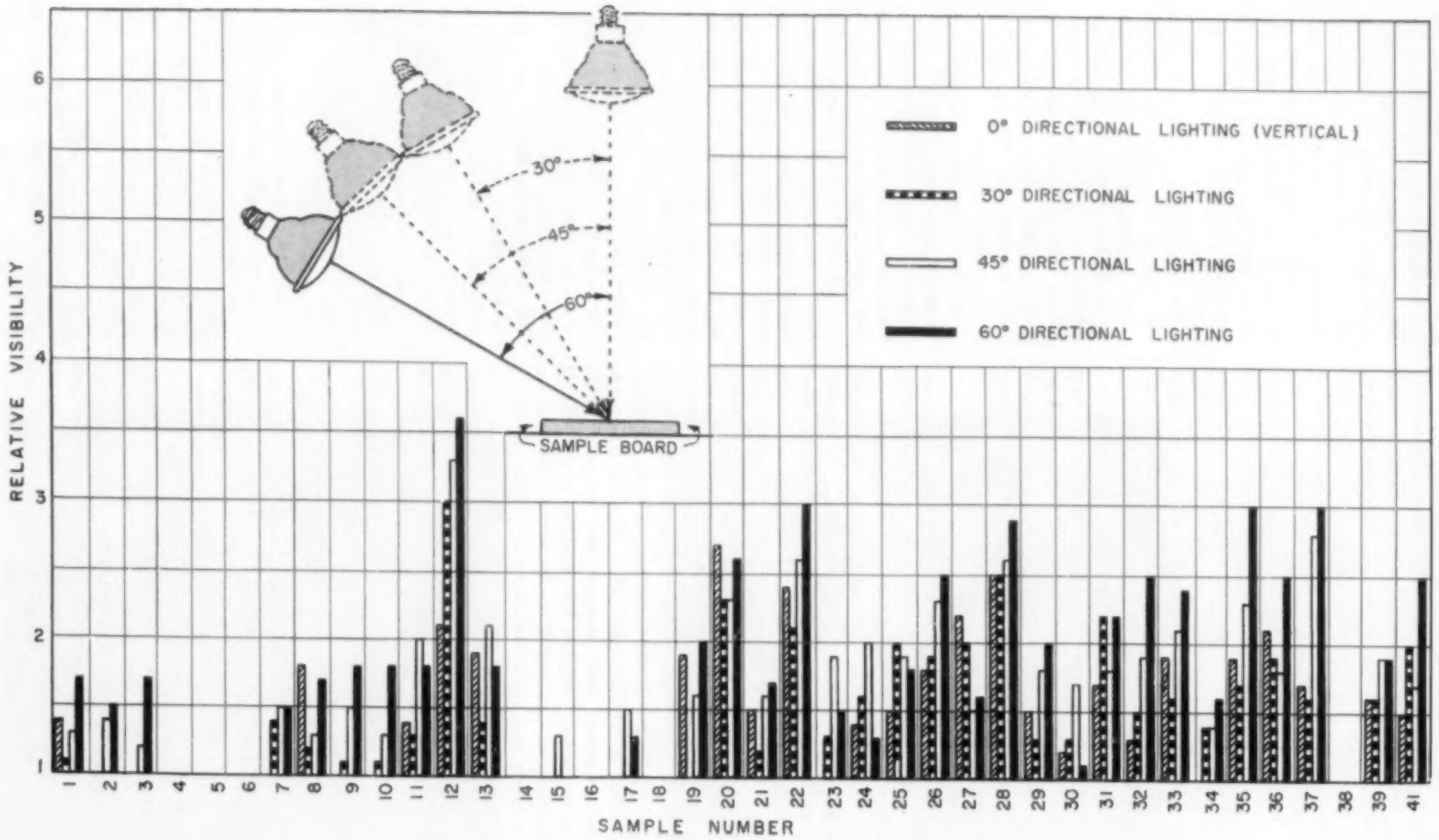


TABLE I — Point Source (Directional Lighting).

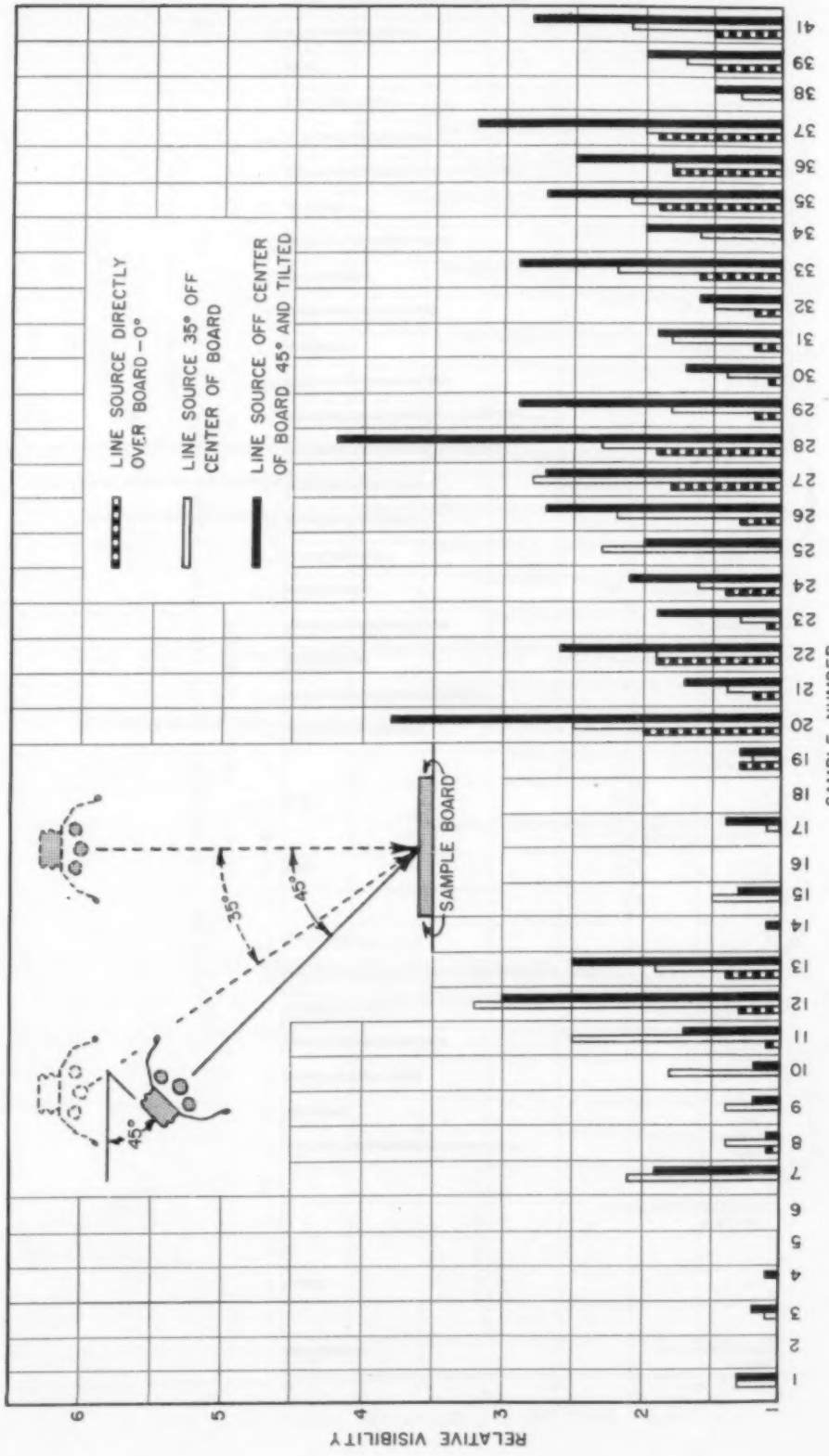


TABLE II — Line Source.

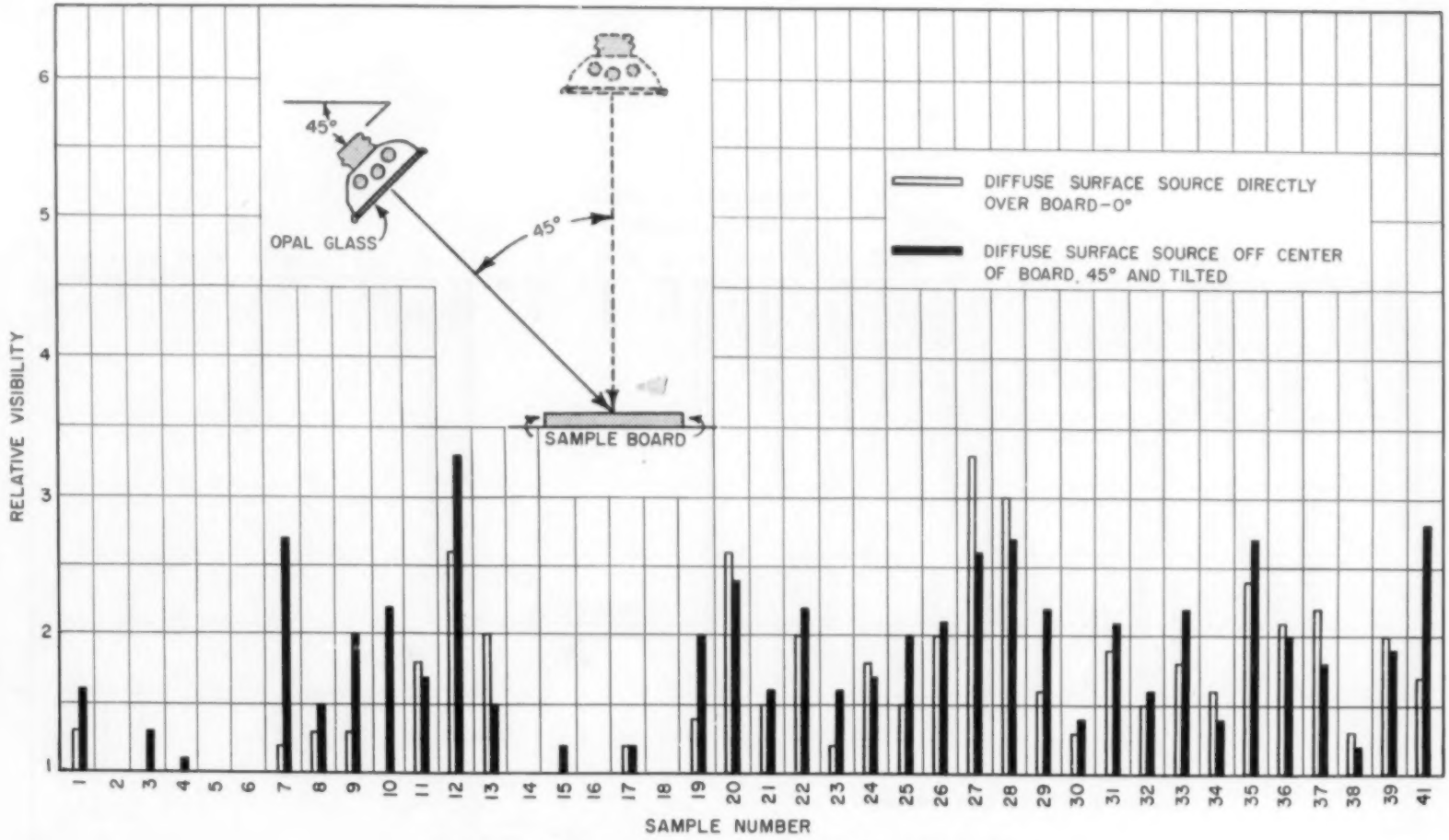

45°
OPAL GLASS
45°
SAMPLE BOARD
DIFFUSE SURFACE SOURCE DIRECTLY OVER BOARD—0°
DIFFUSE SURFACE SOURCE OFF CENTER OF BOARD, 45° AND TILTED
RELATIVE VISIBILITY
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 41
SAMPLE NUMBER

TABLE III — Diffuse Surface Source ($12\frac{11}{12}$ inches x $268\frac{3}{4}$ inches).

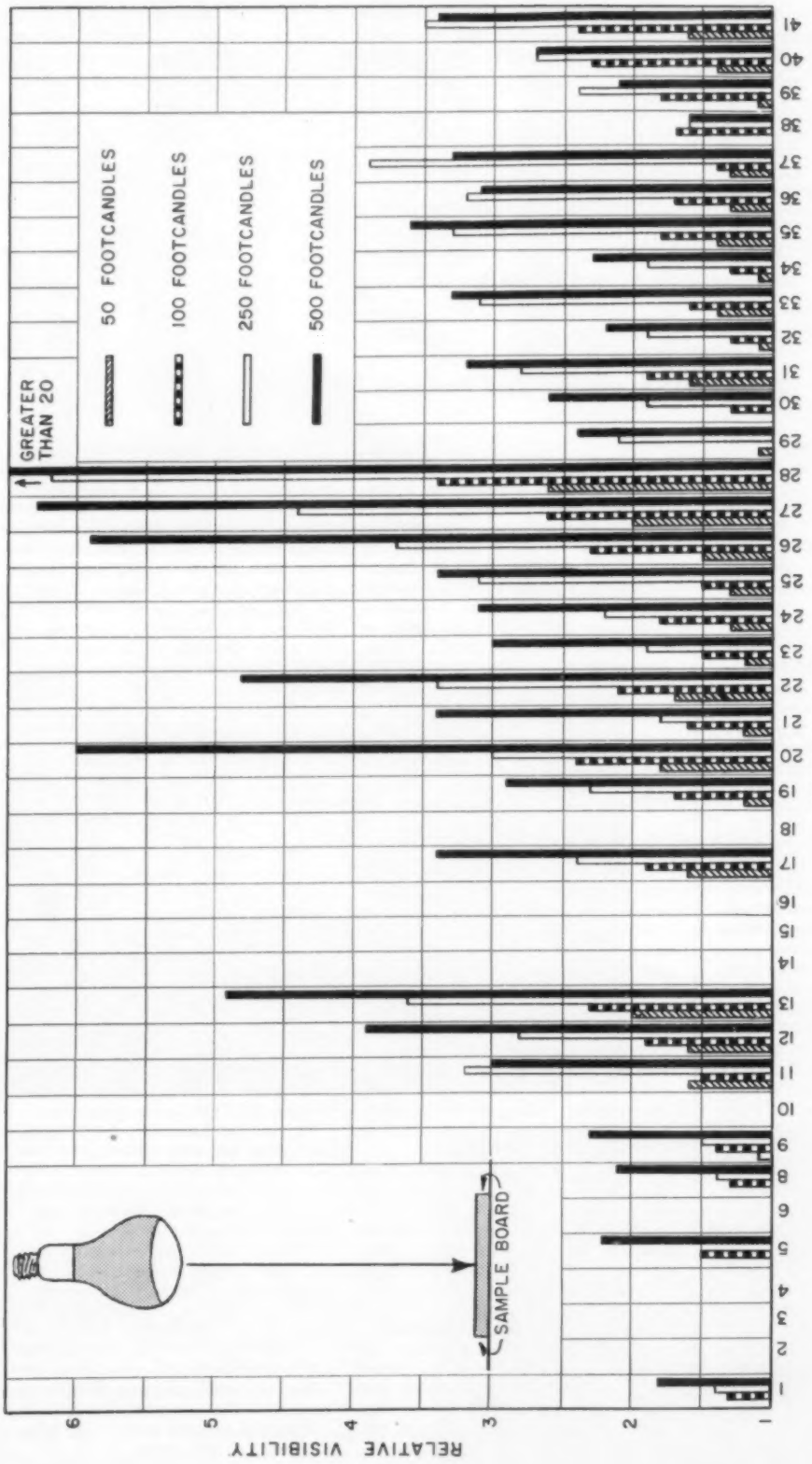


TABLE IV — Effect of Amount of Illumination.

checked before and after the lighting was changed. He was previously working under fluorescent lamps in standard industrial units. These units had been so located as to shield all direct glare from the grader's eyes as well as to produce an average level of illumination on the board of about 100 footcandles. The accuracy of the grader under these lighting conditions was checked by an inspector of the California Redwood Association. Bundles of siding graded under these conditions were opened in sunlight and thoroughly examined from end to end. The accuracy or efficiency of the grader for the above conditions under which he had been working was found to be 81 per cent.

(b) The lighting was then changed to the directional incandescent system and sufficient time was allowed for adjustment to the change before making another check. Using the directional incandescent lighting system with the same grader and as nearly the same conditions as possible the percentage of accuracy went up to 90 per cent. It was not possible to eliminate all other variables in the sample involved, so that all of this improvement can not be claimed for lighting. However, the management of the mill felt that if half of this improvement were attributed to improvements in lighting, it would still be worth while.

New I.E.S. and American Standard Practices Fill Wide Need

New I.E.S. publications issued within the past few months are filling a long-felt need for definite guides and principles in lighting a wide variety of outdoor locations.

"Lighting Outdoor Locations of Central Station Properties" was prepared under the general supervision of the I.E.S. Committee on Lighting of Central Station Properties, comprising both electric utility and manufacturing members. The illumination of electric utility central stations, and especially generating and substation areas, presents many peculiar seeing problems and conditions which are not typical of industrial work areas in general. This Committee has already prepared three reports covering control rooms, load dispatch rooms and high-bay areas. Another, recommending the lighting of indoor areas, is scheduled for the near future.

The scope of the many outdoor lighting problems involved in central stations extends from the lighting of a building for advertising and display purposes to the lighting of coal piles, and from lighting a simple walkway to the area surrounding entrance gates. Proper lighting of all areas is most important, since generating stations operate on an around-the-clock basis. The recommendations in this report as well as the numerous illustrations will provide electric utilities, large and small, with an excellent guide to lighting their own properties.

Another long-awaited outdoor lighting guide recently published in ILLUMINATING ENGINEERING and soon to be available in booklet form is the new "American Standard Practice for Protective Lighting. This new standard practice is intended as a guide for those industrial plant officials responsible for providing plant protection against trespassing, theft and sabotage, as distinct from recommendations for lighting for industrial production. The report provides description and applications for a wide variety of outdoor lighting equipment, including types of light sources; gives lighting specifications for principal areas; covers circuiting; and illustrates with diagrams and tables various protective lighting applications.

While I.E.S. was the sponsor of this American Standard Practice, an indication of the breadth of the coverage is found in the names of the organizations represented on the A.S.A. Sectional Committee. These include: A.I.E.E., American District Telegraph Co., American Society of Safety Engineers, Association of American Railroads, Association of Casualty and Surety Cos., E.E.I., National Association Mutual Casualty Cos., National Bureau of Standards, N.E.M.A., National Safety Council, together with four bureaus of the U. S. government.

These new booklets may be obtained from Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y. Lighting Outdoor Locations of Central Station Properties is 40¢ per copy; American Standard Practice for Protective Lighting, 50¢ per copy. Quantity prices upon request to the Publications Office.

About 1957 Conference Preprints . . .

The preprints of I.E.S. National Technical Conference papers have always provided in one convenient package a review of all that is new in lighting techniques and development during the year; a report of significant progress. Over the years, most I.E.S. members who have attended the national conferences have been sure to obtain a set of preprints immediately upon arrival for conference sessions, and many have paid in advance to make certain their sets would be available. Others, unable to get to the conference, have ordered sets of preprints mailed to them.

Preprints ordered and paid for in advance for mail delivery offer no problem, and mailing is made immediately upon the preprints becoming available at conference time. However, advance payment with the option of having preprints delivered in person at the conference or mailed to home or office as in the past requires detailed records which must be checked at the conference registration area and which sometimes cause confusion and delay.

In order to minimize any such confusion, and we think, to help the usually over-burdened committee registering delegates, a new plan is being inaugurated for distribution of preprints of papers at the 1957 National Technical Conference, in Atlanta, September 9-13. Instead of accepting advance prepaid orders for delivery *at* the conference, an ample supply of preprint packets will be shipped to Atlanta so that papers for use at conference sessions may be obtained by direct purchase at the conference registration tables.

Here are a few reminders for obtaining 1957 Conference preprints:

If you are attending the Atlanta conference and want preprints for use at conference sessions, there is no need to order them in advance. Just purchase them at the conference registration desk upon arrival.

Whether or not you are attending the 1957 conference but would prefer to have your prints sent to your office or home, order now, for mailing at the time of the conference. Use either the order form sent with the general conference material last month or the coupon appearing on page 48A of this issue of I.E.

Payment may be made with order or billed, as you prefer.

Publications Sales Office

Here and There with I.E.S. Members

FOLLOWING their dinner meeting March 28 (Bill Stannard featured speaker), Northwestern Ohio Section members and guests visited Toledo Edison's modern equipment display. Group numbered 140, including architects, consulting engineers and electrical contractors.

LIGHT CONTROL and Equipment Design Committee meeting at I.E.S. Headquarters. At it for two days were, standing, Eric H. Church, Chairman, Milton Buzan, Elden Witte, Maurice Robertson, Fred Ogden; seated l. to r.: John McLaughlin, William Weibel, Henry Peterson, J. Robertson, Clarence Clarkson and Carl Holden.

S. W. SMITH, Charles Trumbauer and Robert Floyd, of Allentown, Pa., receive certificates of Completion of Illumination Course sponsored by Eastern Pennsylvania Section and Penn State University. Making the presentation is W. S. Stewart, Administrative Head, and T. K. Reeves, Instructor, right. See story, page 23A.

ARCHITECTURAL students win Lighting Design Competition in New England Section's allied arts program. L. to r. are Eugene Frost, Allied Arts Committee Chairman; George A. Roman, Third Year BAC; Arno Angelo Cascieri, Dean of BAC; Harry F. Eagan, Jr., second prize winner and Third Year BAC; Carleton Holden, I.E.S.; and C. Edward St. Martin, third prize winner and Third Year BAC. George A. Roman was the first prize winner.

Here and There with I.E.S. Members

STUDENT winners of the Architectural Design Contest, conducted by the Southern California Section, Los Angeles. L. to r.: Alan Gallion, First Prize. Bob Lee, second place; Leo R. Pederson, third place tie, with Donald B. Woodruff; G. S. Crane, honorable mention; Suat Kepenek, honorable mention.

ARCHITECTURAL student Jon Easley, right, University of New Mexico, is the proud winner of the Allied Arts Competition sponsored by the New Mexico Chapter of I.E.S. Presenting the winner's check is Carl R. Albach, representing I.E.S.

CALGARY members (Chinook Chapter) greet Dex Hinckley, Executive Secretary (center) during his visit to their Fundamentals Lighting Course. Group picture of the Lighting Course lecturers includes: Back row — Martin Vickers, Bob Maxwell, Don Frost, Bill Duke, Archie Levitt, Bob Mason, Bob Shortreed, Kay Kirkland. Front row: Bob Underhill, Dex Hinckley, Gerry Woods, Art Mackie. Missing: Dr. Bernard Tharpe, Fred Dorward.

C.I.E. PAPERS Committee meets in Brussels, April 18, to plan 1959 Congress, Dr. Arthur A. Brainerd (U.S.A.), presiding. Left to right at the Papers Committee: General Secretary Chappat (France), Hon. Secretary LeGrand (France), C.I.E. President, Dr. Walsh (England), Dr. A. A. Brainerd, Chairman, Dr. Barleben (Germany), Dr. Cohu (France) and Dr. Vermeulen (Netherlands). Dr. Brainerd also attended joint meeting of Papers and Scope Committee, Belgian Committee on Arrangements, and a special meeting of the National Illumination Committee of Great Britain.

MID-SOUTH Chapter members held a local "Cabinet" meeting with their Regional Vice-President George Morris during his visit to Memphis May 23. Left to right: George Morris, Jim Fletcher, Program Chairman; M. E. Broom, Lighting Education; Glen McMullen, Chairman-Elect; George Hayes and Bob Ridenour, Board of Managers; and H. F. Collins, Jr., Chairman.

LIGHTING NEWS

The Pittsburgh Story—East Central Regional Conference

The Pittsburgh Section is another of the I.E.S. groups richly endowed with talent. Experience, know-how and organization, of course, blossom their best at a Regional Conference. In any case, it did for the East Central Regional Conference May 23-24, at the Sheraton-Penn Hotel, Pittsburgh, Pa. Pattern of events was in line with the Guide to the Operation of Regional Conferences; the individual presentation of these events was another I.E.S. Dividend, compliments of the Pittsburgh Section.

One of these little "extras"—a dittoed list of registrations, with addresses, ready by the end of the first session. Another —audience participation in the scoring of the MMILJ contest. Judges officially chose the winners, but the audience also kept score unofficially, just for their own amazement. And, of course, a brilliant party for 250 the closing evening.

Technical Program

With J. A. Hodges, General Chairman presiding, the conference got off to a good start with an exceptionally apt keynote address and welcome to Pittsburgh by the Mayor of Pittsburgh, David L. Lawrence. Nelson Warner, Regional V-P addressed the group for a welcome to the Region, which he noted constituted 10 per cent of the Society's membership. The meeting was then turned over to W. R. Mackinney, Chairman of the Philadelphia Section who presided at the first technical session.

First of the four technical sessions presented at the conference was an especially timely Symposium on Extended Area Lighting (luminous ceilings). E. D. Altree, first speaker on this symposium, suggested that the continuous, vast-area overall luminous ceiling is on the wane. He showed recent trends for this system of lighting, featuring panels, decorative ideas, and ceiling treatments using colored patterns and design. He noted especially the contribution luminous ceiling lighting systems have made to effective draft-free air conditioning, and in connection with their maintenance suggested the expense of this could be reduced if the plenum area is kept as free of dust as possible.

George Clark, next speaker on this symposium, made the point that the luminous ceiling system gives good lighting and comfort, violates no known lighting principles — but does not provide the "third dimension" he advocates — that of "pleasantness." He noted that the ceiling is the only area in the room which is available to one's view without obstructions, and recommended the planning of color, form and texture for the ceiling area, to relieve monotony of extended area lighting. Further to obtain his recommended characteristic of pleasantness in lighting, Mr. Clark urged the planning for integration, function, and character. The audience viewed, with glasses, stereo slides of installations and designs, some of them miniature mock-ups, which incorporated these elements. His final point, lighting people should not be just avoiding discomfort, but should also be providing pleasantness.

E. J. Kelly, Commercial Committee, Pennsylvania Electric Association, was the final speaker on this Extended Area Symposium. Mr. Kelly, described in detail, with slides, the survey his trade association had made throughout Pennsylvania to collect and analyze data on luminous ceilings. To do this, they studied carefully some 52 installations. Analysis of the survey data brought forth some interesting variations. Cost per square foot for instance: 36 of the installations were only $1.39 per square foot, some very much higher. Levels of illuminations of the 52 luminous ceiling installations studied ranged from 23 footcandles up to 175 footcandles; average for the 52 was 75 footcandles. Spacing of the lamps ranged from 18-inch to 60-inch centers. Of the types of plastic used, 41 were vinyl. There were also wide variations in plenum depth, and height of mounting.

Second technical session was directed by C. A. Oerkvitz, chairman of the Eastern Pennsylvania Section. First speaker was D. R. Phillips on "Recent Trends in Industrial Lighting, Including New Sources." He noted that with the availability of the power groove lamp, trend in industry is toward very high levels, with comfort. He showed several new installations having levels of the order of 1000 footcandles. Redesign of fixtures,

OFFICERS from the five Sections and Chapters of the East Central Region discussed regional problems at a valuable Local Activities meeting May 22. Contributing valuable advice and constructive criticism were National President, Marshall N. Waterman; Vice-President George J. Taylor; Past Regional Vice-President Paul H. Hildebrand; and I.E.S. Executive Secretary, A. D. Hinckley.

The Pittsburgh Story

AT THE first technical session May 23, these gentlemen formed a team to present a valuable symposium on present-day practices for luminous ceilings. L. to r.: E. J. Kelly, Director of Commercial Sales, Duquesne Light Company, and acting as a reporter for the Commercial Committee, Pennsylvania Electric Association; E. D. Altree, Pittsburgh Reflector Corp.; W. R. Mackinney, Chairman of the session and of the Philadelphia Section; and G. W. Clark, Sylvania Electric Products Inc.

KEYNOTER for opening session was Mayor of Pittsburgh, the Honorable David L. Lawrence (left). His escort to the conference, Joseph S. Schuchert (right).

SPEAKERS for the technical session on recent trends in lighting. L. to r.: W. S. Fisher and D. R. Phillips, General Electric, Nela Park; C. A. Oerkvitz, Chairman of the session and of Eastern Pennsylvania Section; and W. W. Weld, Revere Electric Mfg. Co.

VIRGINIA Chapter was elevated to the status of a Section, receiving its new Charter during the Conference. Presenting the Charter is Marshall Waterman, left; receiving it Dean N. Jenks, Chairman of the Virginia Section. Nelson C. Warner, East Central Regional V-P, looks on.

MMILJ competition was a technical highlight of this conference, just as it always is at the local, regional and national levels. L. to r. H. M. White, Maryland Section; A. G. Zitelli, Pittsburgh; Simon Ehrlich, Philadelphia Section (first prize Residential); H. V. Oerting, Chairman of the Competition; George C. Linthicum, Philadelphia; and Werner F. Rosacker, Eastern Pennsylvania Section (first prize, Commercial).

FOUR busy, hard-working gentlemen were these (above) during the two days of the conference. L. to r.: James A. Hodges, General Chairman of the conference; Nelson C. Warner, Regional Vice-President; National President Marshall N. Waterman; and James P. Boyden, Host Chairman, Pittsburgh Section.

FRIDAY luncheon meeting (right) at East Central Regional.

he said, would be another trend originating from the new sources now being developed, especially for greater shielding of power groove lamps.

Will Fisher, General Electric predicted new trends in office lighting. With slides and details he demonstrated an experimental office having levels of 500 footcandles. Results of working for one year within this prototype installation included: general preference by visitors given a choice of levels, of 200 to 300 ft-c; no one has ever chosen less than 100 ft-c. With 21 watts per square foot, it was found air conditioning necessary to make such levels practicable; during cold weather no additional heat needed. From his experience, he advocates special shielding or other factors, for levels of this nature.

MMILJ

Five first-prize winners from the Sections competed at the Regional level for "My Most Interesting Lighting Job." As with other Regional Conferences, it was one of the highlights of the program. Judges Marshall Waterman, George J. Taylor, C. L. Crouch and D. N. Jenks (of the Virginia Section) selected the following:

First Prize, Class II: Werner F. Rosacker, Eastern Pennsylvania Section. His job — Memorial Church.

First Prize, Class I: Simon Ehrlich, Philadelphia Section, for "Brightness Balance in the Home."

Second, Class II: George Linthicum, Philadelphia Section for his interesting installation in a relighted bank.

Third Prize, Class II: Armand Zitelli, Pittsburgh Section — remodeling a

VISITING ladies (left) were entertained at luncheon at Gateway Center, to mention only one of the several events included in the special program planned for them by Mrs. James P. Boyden and her Ladies Committee. Highlight of the social program, and a fitting climax to the successful conference was the dinner-dance (below) attended by 250 celebrants. Reception and dinner were in honor of President and Mrs. Waterman.

LUNCHEON session addressed by President Waterman. Presiding at this session was James P. Boyden, Chairman of the Pittsburgh Section.

truck storage garage into an office, display and sales area.

SOCIAL AFFAIRS

The dinner-dance in honor of President and Mrs. Waterman has already been mentioned; a brilliant affair Friday evening, May 24. The guests of honor received a gift from the Region to commemorate the event — a beautiful silver coffee pot with creamer and sugar.

The Ladies Program was under the direction of Rosemary Boyden (Mrs. James P., Jr.). With a suite to themselves the 30 ladies attending met every morning for brunch, and in addition enjoyed the well-planned program outlined for their pleasure. These included a trip through the University of Pittsburgh, the highlight being a tour of the university's "Nationality Rooms." On May 23 they had luncheon at the Park Schenley, and on May 24 a luncheon party was held in the Management Dining Room of the Westinghouse-Jones & Laughlin Steel Corp., in the new Gateway Building. Other trips included a scenic incline ride to Mt. Washington, a tour of the H. J. Heinz Company, a visit to "The Aviary," and general sight seeing.

TECHNICAL SESSIONS

Wednesday Evening, May 22

Meeting of Local Activities Committee. N. C. Warner, Regional Vice-President, presiding.

Thursday Morning, May 23

Presiding, J. A. Hodges, General Chairman
A New Pittsburgh Welcomes You — the Honorable David L. Lawrence, Mayor, City of Pittsburgh.
The Region Welcomes You — Nelson C. Warner, Vice-President.

First Technical Session

Presiding: W. R. Mackinney, Chairman, Philadelphia Section
Present-Day Practice in Extended Area Lighting Systems — E. D. Altree, Pittsburgh Reflector Company.
An Architectural Concept of Extended Area Lighting — G. W. Clark, Sylvania Electric Products Inc.
Installation and Performance Data on Recent Extended Area Systems—E. J. Kelly, Pennsylvania Electric Association.

Thursday Afternoon, May 23

Presiding: J. P. Boyden, Chairman, Pittsburgh Section
President's Luncheon. "New Demands Challenge Our Lighting Industry" by Marshall N. Waterman, President, I.E.S.

Second Technical Session

Presiding: C. A. Oerkvitz, Chairman, Eastern Pennsylvania Section
Recent Trends in Industrial Lighting, Including New Sources — D. R. Phillips, General Electric Lamp Division, Nela Park.
High Level Lighting in Offices and Drafting Rooms — W. E. Fisher, General Electric Lamp Division, Nela Park.
Exterior Lighting for the Modern Shopping Center — W. W. Weld, Revere Electric Manufacturing Company.

Friday Morning, May 24

Third Technical Session

Presiding: H. V. Oerting, Chairman, Capital Section
Regional Competitors, My Most Interesting Lighting Job
George Linthicum, Philadelphia Section
Simon Ehrlich, Philadelphia Section
Armand G. Zitelli, Pittsburgh Section
H. M. White, Maryland Section
Werner F. Rosacker, Eastern Pennsylvania Section.

Friday Afternoon, May 24

Presiding: Dean N. Jenks, Chairman, Virginia Section
Luncheon Session. "Dynamic Progress in I.E.S. Research" by C. L. Crouch.

Fourth Technical Session

Presiding: C. E. Sparrow, Chairman, Maryland Section
Rayescence — Dr. E. A. Sack, Electronics and Nuclear Physics Dept., Westinghouse Electric Corp.

Friday Evening, May 24

President's Dinner-Dance — Master of Ceremonies, J. P. Boyden, Host Chairman, Pittsburgh Section.
Presentation of M.M.I.L.J. Awards.

CREDITS

The following committee chairmen were responsible for the direction of this conference:

Executive Committee

N. C. Warner, Regional Vice-President
J. A. Hodges, General Chairman
J. P. Boyden, Host Chairman
W. P. Thayer, Vice-Chairman
J. S. Schuchert, Secretary
J. S. Frizzel, Treasurer

(*Continued on page* 15A)

Annual Meeting

In accordance with Article VII Section 1 of the Constitution, the Annual Meeting of the Society is scheduled to be held at Society Headquarters 10 a.m., Thursday, October 10, 1957. The meeting will receive a report of the proceedings of the Society for the fiscal year 1956-1957.

R. G. SLAUER
General Secretary

DECIDEDLY BETTER
DAY-BRITE
Lighting Fixtures

DAY-BRITE LIGHTING MAKES THE BIG DIFFERENCE HERE

There's no compromise here

In the laboratory, under a microscope, life itself may hang in the balance. Vital work done here demands the best in lighting—Day-Brite lighting that provides better over-all illumination, without tricky shadows or glare.

Don't take our word for it. Compare fixtures. We'll stake our reputation on what you find. For we *know* you'll find that Day-Brite does offer better lighting . . . is built to last years longer . . . does offer cost-cutting maintenance in an attractive fixture design.

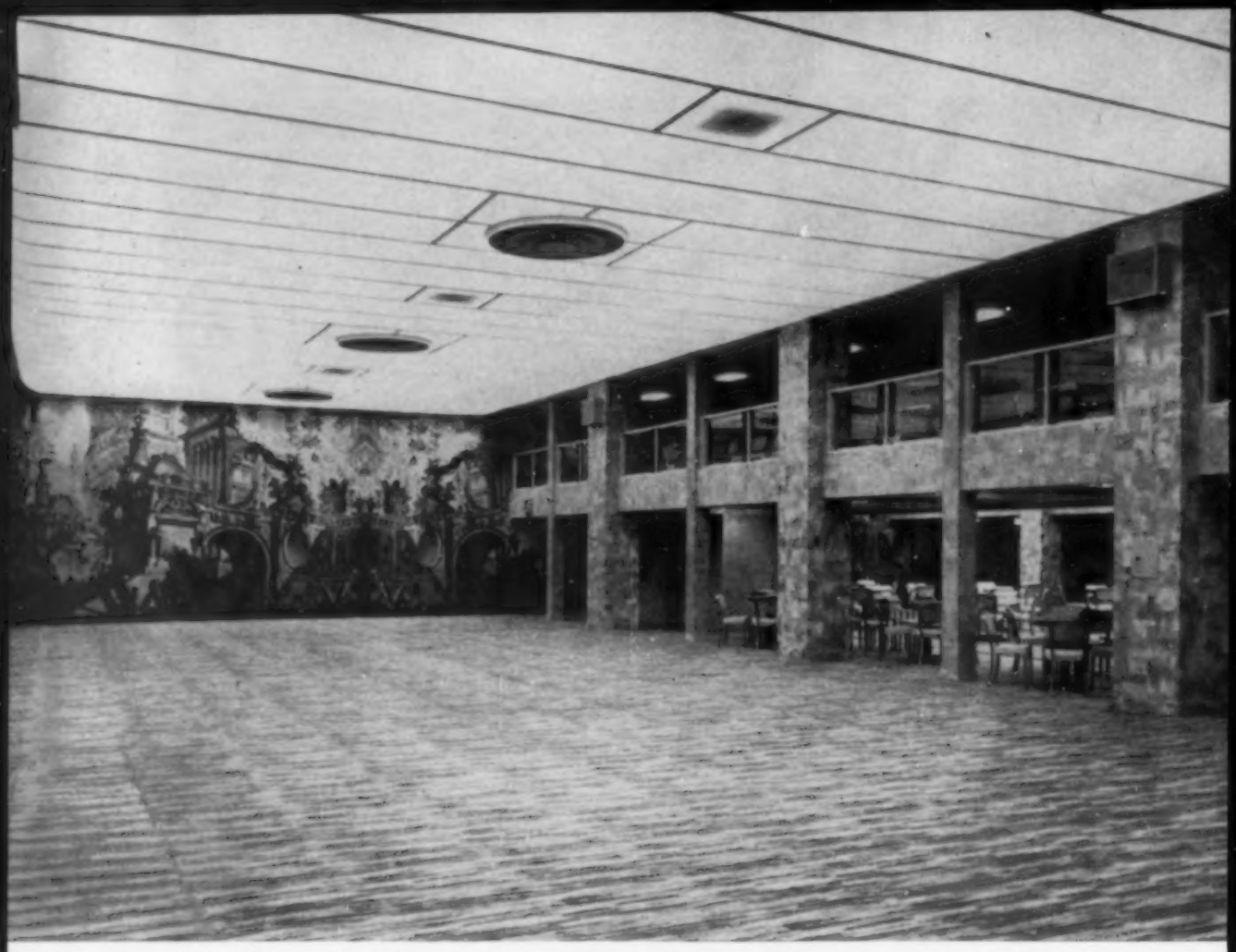
You'll also discover how Day-Brite can answer many other lighting problems, in reception areas, corridors, offices, patient rooms, kitchens and libraries.

Call your Day-Brite representative for a demonstration today. He's listed in the Yellow Pages. *Day-Brite Lighting, Inc., 5432 Bulwer Avenue, St. Louis 7, Mo. Day-Brite Lighting, Inc., of California, 530 Martin Ave., Santa Clara, Calif.*

NATION'S LARGEST MANUFACTURER
OF COMMERCIAL AND INDUSTRIAL
LIGHTING FIXTURES

Day-Brite Plexoline® fixtures, prescribed for exacting laboratory work in Cardinal Glennon Memorial Hospital, St. Louis.
Architect-Engineers: Maguolo & Quick

71181



2,300 square feet of light in a ballroom of New York's Park Sheraton Hotel can be varied in intensity to suit the activity. End sections are curved to enclose the fixtures near the balcony. The panels resist warping, cracking and discoloration—are normally unaffected by moisture and oil. Another UL listed installation. Ceiling components in this installation by **Luminous Ceilings Inc.**, Chicago, Ill.

Made easy with BAKELITE Rigid Vinyl Sheet . . .

2,300 square feet of brilliant light

Easy to design . . . easy to install . . . easy to maintain, that's the comment heard from architects, contractors, maintenance men and owners. No wonder then, that so many installations of new lighting specify a luminous ceiling . . . with translucent panels made of BAKELITE Brand Rigid Vinyl Sheet. And workers and customers have the benefits of lighting with the proper intensity . . . freedom from annoying glare and shadows.

Now, find out more about illuminated ceilings . . . to modernize old areas . . . to throw a new light on modern interiors. For further information write Dept. YP-82.

BAKELITE
BRAND
PLASTICS

UNION CARBIDE

BAKELITE COMPANY, *Division of Union Carbide Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The terms BAKELITE, UNION CARBIDE and the Trefoil Symbol are registered trade-marks of UCC.

(*Continued from page* 12A)

Members, Executive Committee

H. C. Oerting, Capital Section
A. J. Rugo, Capital Section
C. A. Oerkvitz, Eastern Pennsylvania Section
R. J. Pretzman, Eastern Pennsylvania Section
C. E. Sparrow, Maryland Section
P. J. Puckett, Maryland Section
W. R. Mackinney, Philadelphia Section
R. L. Herr, Philadelphia Section
D. N. Jenks, Virginia Chapter
T. P. Harris, Virginia Chapter

Committees

Program — C. M. Crysler, General Electric Co.
Publicity — G. H. Maize, Duquesne Lighting Co.
Registration — E. B. Colby, Sylvania Electric Products Inc.
Hotel — A. R. Hampsey, Jr., Duquesne Light Co.
Transportation — H. J. Mazur, Westinghouse Electric Corp.
Entertainment — H. R. Jones, West Penn Power Co.
Ladies' Reception and Entertainment — Mrs. James P. Boyden, Jr.
President's Dinner-Dance — C. D. Miller, Duquesne Light Co.

North Texas Section New Name For Southwestern

The I.E.S. Section located in Dallas, Texas, formerly known as the Southwestern Section, will henceforth be known as the North Texas Section. Growth of other Chapters and Sections in the Texas areas is the chief reason. The action was discussed last fall by the Section's Board of Managers, seeking a name which would be more descriptive of the area served, and to eliminate confusion between the name of the Section and the Southwestern Region.

The membership was polled with 80 per cent being in favor of a change. Of the names suggested by the members, "North Texas Section" was mentioned the most. Council was petitioned at its April meeting, with unanimous approval for the new name.

Milwaukee Gemuetlichkeit for the Midwest Regional Conference

A nice blend (or should one say meld) of Milwaukee warmth and enthusiasm, and a highly educational technical program, was the outstanding characteristic of the Midwest Regional Conference. The Milwaukee Braves got into the act, naturally. Highlights of their 1956 achievements were part of the fun at the pre-conference get-together at the Miller Brewing Company. So was group singing, good fellowship over a beer, Milwaukee fashion, and a tour of the brewery. All this was on the evening of May 8, following an all-day session of the Council Executive Committee which held its meeting in Milwaukee the day before the Conference.

On May 9 the technical aspects of the conference got under way, for some eight sessions in two full days. Following an invocation, the conference was opened with an address of welcome by Hon. Frank Zeidler, Mayor of Milwaukee, and William Lisch, Chairman of the Milwaukee Section. B. R. Bunn, Conference Chairman, presided. Another feature of the opening ceremonies was a Report on the Midwestern Region, by Joseph A. Schneller, Regional Vice-President.

MMILJ

Organization and execution of the contest for My Most Interesting Lighting Job in the Midwest Region, could well serve as a model for the entire structure of this contest. Each of the Region's 10 Sections and Chapters appoints an enthusiastic Contest Chairman. These, in turn, are under the direction, for the entire year, of a Regional Contest Chairman. This was, again this year, Ernest Gallet, who completed his assignment in conducting the final Regional contest as a special session May 9.

Such attention to organization and detail paid off well, as it has every year for this Region. Every one of the ten local groups held a contest, some of them with as many as 19 local contestants. At the Regional level, only two of the local winners (Twin Ports and Indiana) were unable to attend the Regional contest, where thirteen entries in both Residential and Commercial classes were presented. The results:

First Prize, Commercial: Henry J. Poehling, E. H. Lauth Associates, St. Louis Section. This job, "St. Louis Municipal Airport."

Second Prize, Commercial: E. C. Knudson, Cornhusker Section. "Lighting a Conference Room."

Third Prize, Commercial: James K. Carlson, Architect, Twin City Section. "Lighting Our Savior's Lutheran Church."

First Prize, Residential: Edwin Schnoll, Standard Electric Supply Co., Milwaukee Section. "Modern Residence Lighting."

Second Prize, Residential: Mrs. Doris McCutchen, Central Illinois Light Co., Peoria, Illinois, Central Illinois Chapter. "Outdoor Lighting for Family Living." (Entry presented by Delwin Schneider.)

Third Prize, Residential: Frank R. Valvoda, Frank R. Valvoda & Associates, Chicago Ill., Chicago Section. "Lighting a Complete Residence."

Other contestants in the Regional Contest, all of whom had won first prizes in

(*Continued on page* 16A)

LUNCHEON Session at midwest Regional Conference, Milwaukee, May 10. In background, President Waterman receives books on Milwaukee and Wisconsin as a memento of the 1957 Conference.

HEAD table at luncheon session May 9. L. to r.: C. L. Crouch, I.E.S. Technical Director; J. A. Schneller, Regional V-P; B. R. Bunn, Conference Chairman; William Lisch, Milwaukee Section Chairman, and Marshall Waterman, I.E.S. President.

Ed Schnoll, right, St. Louis Section, receives congratulations as winner of the Residential section of My Most Interesting Lighting Job Competition. President Waterman presented the award. At right, Henry J. Poehling, St. Louis Section, winner of the Commercial section of the contest, receives his award from President Waterman.

Time: May 9-10, 1957
Place: Hotel Pfister, Milwaukee, Wis.
Attendance: 275
Delegates 218
Ladies 59
1958 Conference: Kansas City, Mo.

(*Continued from page* 15A)

their respective Sections and Chapters were:

Class I, Residential

Neil J. Thompson, Heart of America Section.

Charles A. Meyer, St. Louis Section.

Dorothy A. Blake, Cornhusker Section.

Class II, Commercial

L. J. Widigen, Iowa Section.

G. D. Moore, Twin City Section.

C. E. Carter, Central Illinois Chapter.

Henry T. Koether, Milwaukee Section.

Erwin J. Cook, Heart of America Section.

Judges for the Regional contest were, for Class I, R. G. Slauer, A. L. Sangster, Marshall Waterman. For Class II, C. L. Crouch, Kirk Reid, R. D. Burnham.

Technical Program

Full details of the papers presented are given at the end of this report. Particular mention could be made, however, of the two panel sessions, "Proper Lighting for Young Eyes," and "Luminous Ceilings, Integrating Problems of Acoustics, Air Conditioning and Lighting." Both these sessions constituted high level symposiums on the subjects and developed considerable audience participation.

Socially

In spite of a full technical program, the men attending this conference were able to participate in several social events planned for the entire group. In addition to the Gemeutlichkeit party which preceded the meetings, they enjoyed a tour of the new Employee Club of the Wisconsin Electric Power Company Friday afternoon, and a buffet supper there Friday evening. Highlight of the social program, was of course, the President's Reception and Cocktail Dance Thursday evening. This was in honor of President and Mrs. Marshall Waterman, held in the Fern Room of the Hotel Pfister.

Fifty-nine ladies present enjoyed a program of their own. They also took part, of course, in the Wednesday evening party at the Miller Brewing Company, the President's Dance, and the buffet supper Friday evening. In addition they met each morning for a Kaffee Klatsch, with door prizes, and for luncheon Thursday at Watts Tea Shop. Here they heard a talk by George Watts, Jr., on "A Philosophy of Living for Your Home." A bridge luncheon was held Friday afternoon at the beautiful North Hills Country Club, local I.E.S. wives forming car pools for the scenic drive to the club.

Program

A complete list of the sessions program includes:

May 9, Thursday Morning

Presiding Chairman, B. R. Bunn, Chairman, 1957 Midwestern Regional Conference I.E.S.
Invocation.
Welcome to Milwaukee — Hon. Frank Zeidler, Mayor of Milwaukee; William Lisch, Chairman, Milwaukee Section.
A Report on the Midwestern Region — Joseph A. Schneller, Vice-President, Midwestern Region.
"My Most Interesting Lighting Job" Contest— E. H. Gallet, Midwestern Regional Contest Chairman.

Luncheon Session

Presiding Chairman, William Lisch, Chairman, Milwaukee Section
Luncheon Address — Marshall N. Waterman, National President, I.E.S.

Thursday Afternoon

Presiding Chairman, A. A. Aronson, Chairman, Twin City Section
Panel Session: "Proper Lighting for Young Eyes — At School and at Home."
Speakers:
Lawrence E. Johnson, Supervisor, Commercial Sales, Northern States Power Company, Minneapolis, Minn.
Richard F. Hammel, Hammel & Green Architects, Inc., St. Paul, Minn.

(*Continued on page* 19A)

Cornhusker Section, recently elevated to this status from Chapter, received its new Charter from President Waterman at appropriate ceremonies during the Conference. Ford Bates, the Section's Chairman, right, accepted the Charter.

A MERCURY LAMP BALLAST

Operating Under Water?

NEW ***Jefferson*** BALLAST WITH EXCLUSIVE **AQUALIFT** SEALANT ELIMINATES MOISTURE FAILURE IN POLE BASE INSTALLATIONS

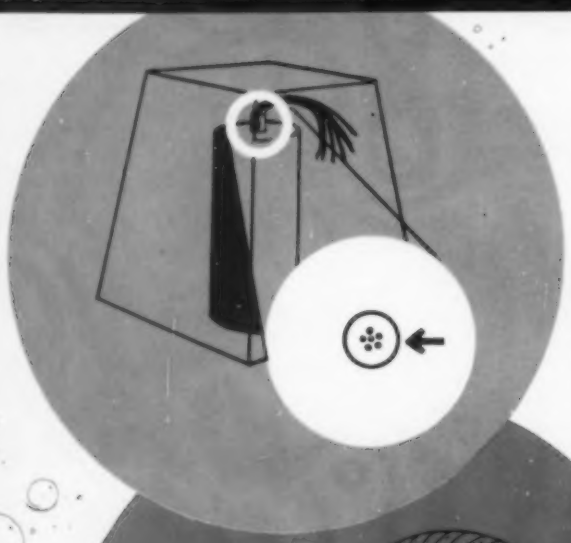
No—they're not meant for underwater operation, and we know you're not using them for that purpose. But . . . most pole base ballasts *are* subjected to moisture hazards from condensation drips, storm leakage, and gutter overflows. So—to be *sure* that the new Jefferson mercury lamp ballast is absolutely impervious to *any* moisture damage, it was subjected to the most *severe* tests we could devise. Through on/off operations, *in* and *out* of water, with *high heats* and *quick cool-offs*, NOT A SINGLE TRACE OF MOISTURE was able to break through the waterproof barriers of this new ballast. Now—with this new Jefferson development—you can make pole base installations with complete safety—at an important saving of your time and money.

SEE THE BACK OF THIS PAGE FOR THE COMPLETE STORY

30 DAY UNDERWATER TEST GIVES POSITIVE PROOF THAT NO MOISTURE CAN ENTER THIS JEFFERSON BALLAST.

(a) Continuously submerged for 15 days—tested on lamp with alternate cycles of 8 hour operations followed by 16 hour shut-offs. No change in insulation resistance gave *positive evidence of no moisture in ballast.*

(b) Intermittent submersion for 15 days—with alternate cycles of on-operation for 8 hours out of water . . . followed by 16 hours of shut-off, underwater. *Again*—no change in insulation resistance gave proof of *no moisture inside ballasts.*



THE SECRET IS IN THE **AQUALIFT** SEALANT . . . AN EXCLUSIVE JEFFERSON DEVELOPMENT!

To prevent moisture from entering the otherwise weatherproof case through the pipe nipple that provides an exit for the ballasts leads, Jefferson engineers developed a revolutionary new sealing compound. Retaining its sealing properties through extreme heat and freezing cold, it prevents "breathing" through sudden temperature changes, *maintains* air and moisture-tight closure around and between leads and nipple tunnel.

NO TAPING REQUIRED . . .
cuts installation time in half!

Now you can completely eliminate the time-consuming costly weatherproof taping of pipe nipples or wiping sleeves. Formerly it was necessary to (1) tape over nipple and up on leads with rubber tape or scotch fill (2) cover this with at least two layers of lapped plastic tape (3) cover this with friction tape and paint. With the new Jefferson mercury lamp ballasts you just splice-and-tape line and lamp leads and the job is done!

NO NEED TO "**BABY**" THIS BABY . . .
lift it by the leads if you like

Greatest single cause of damage to pole base ballasts has been the common practice of using the ballast leads as *handles*. Now you can do this with safety, for the new Jefferson waterproof sealant withstands up to 500 lbs. pull when it is lifted by all the leads at once . . . a multiple safety margin for the roughest handling.

YOU PROFIT THREE WAYS . . .

1. **No Handling Damage** — Unusual ruggedness eliminates time consuming trips for replacement—voided guarantees—premature breakdowns.
2. **Faster, Easier Installation** — Count up the labor costs of triple taping and estimate the dollars you save by eliminating these operations.
3. **Fewer Call Backs** — Each instance of pole base ballast failure costs you time and money to make replacements. Keep your costs within original estimate, with moisture-proof Jefferson ballasts.

Jefferson ELECTRIC COMPANY
BELLWOOD, ILLINOIS

PRODUCTS WORTHY OF THE NAME

(*Continued from page* 16A)

Dr. Frederick W. Hill, Assistant Superintendent of Schools, Minneapolis, Minn.
Dr. D. A. Franz, Optometrist, De Kalb, Ill.
C. L. Crouch, Technical Director, I.E.S.
Discussion: M. R. Weiman, Central Illinois Chapter, Discussion Leader.
Presidents Reception and Cocktail Dance

Social Chairman, Robert Wittenberg

MAY 10 — FRIDAY MORNING

Presiding Chairman, Ford Bates, Chairman, Cornhusker Section

Panel Session: "Luminous Ceilings — Integrating Problems of Acoustics, Air Conditioning and Lighting."
Speakers:
"Acoustical Treatment" — H. U. Baker, Celotex Corp., Chicago, Ill.
"Air Conditioning — Design Coordination" — Charles H. Randolph, Wisconsin Electric Power Company, Milwaukee, Wis.
"Lighting Design' — R. D. Burnham, The Wakefield Company, Vermilion, Ohio.
"Electroluminescence — A Progress Report" — Carl F. Jensen, Westinghouse Electric Corp., Bloomfield, N. J.
Discussion: Clarence Clarkson, Central Illinois Chapter, Discussion Leader.
Luncheon — Presiding Chairman — Robert Welch, St. Louis Section.
Luncheon Address: "Putting a Shopping Center Together" — Walter Kroening, Capitol Court, Milwaukee, Wis.

FRIDAY AFTERNOON

Presiding Chairman, Eric H. Church, Chairman, Chicago Section

Panel Session: "Lighting and Lamps."
Speakers:
"Industrial Lighting Developments" — Don Caverly, Sylvania Electric Products Inc.
"Light Sources" — Kirk Reid, General Electric Company.
Discussion: Orlo W. Oberlander, Central Illinois Chapter, Discussion Leader.
Tour — The Fabulous New Employee Club of the Wisconsin Electric Power Company, Milwaukee, Wis.
Buffet Supper — Wisconsin Electric Power Company, Charles N. Laupp, Presiding.

CREDITS

Success of this conference brings credit to all concerned with it, especially the following:

Joseph Schneller ..... Regional Vice-President
"Bev" Bunn ..... Conference Chairman
Ward Gustafson .... Conference Vice-Chairman
Charles Laupp ..... Conference Secretary
Edward Grieb ..... Conference Treasurer

COMMITTEE CHAIRMEN

Ralph Cheney, Robert Vandenboom } ... Papers and Program
Robert Wittenberg .... Entertainment and Social
Sam Cook ..... Attendance and Publicity
Arthur Wanty ..... Decorations and Display
Edward Grieb ..... Finance
Paul Owens ..... Transportation
William Lisch ..... Registration and Reception
Everett Schaefer ..... Hotel

Ladies Committee

Mrs. Mildred Lessenich ..... Chairman
Mrs. Dorothy Laupp
Mrs. Jean Dustin
Mrs. Vera Cheney
Mrs. Dorothy Schnoll
Mrs. Bea Aik
Mrs. Rose Madigan

Six Years Issues IE Offered Free

Complete issues of ILLUMINATING ENGINEERING from 1949 through 1954 will be donated to anyone wishing them, per information from Mr. Leslie D. Lyon, Consumers Power Company, Jackson, Michigan. First come, first served.

ST. MAURICE VALLEY Charter, for the new I.E.S. Chapter in Trois Rivieres, Quebec, is accepted by the Chapter's first Chairman, Jean Lafontaine, left. Joe Thomas, Regional Vice-President made the presentation.

Arizona Allied Arts Competition Names Winner

First Place Award in the Allied Art Competition sponsored by the Arizona Section of I.E.S. went to Larry Jones, an architectural student at Arizona State College at Tempe. Mr. Jones' entry featured a lighting study of a proposed local utility office, auditorium and service department. The competition was held May 8, at the Arizona Manor Holiday Restaurant, Phoenix, with seven entries by students of the architectural department of the college.

Second and third place awards went to Craig Walling, Jr., and David Hunt respectively. Leader of the group was James Elmore, A.I.A., Associate Professor of Architecture at Arizona State College.

St. Maurice Valley Chapter Celebrates Charter Night

Official presentation of its Charter was celebrated May 10 by the new I.E.S. Chapter, St. Maurice Valley, in Trois Rivieres, Quebec, Canada. The new Chapter is the second bilingual group within the Society, conducting its meetings in French, as does the Quebec Chapter. Joe Thomas, Canadian Regional Vice-President made the presentation; the Charter was received for the new group by the Chapters Chairman, Jean Lafontaine.

Several special guests attended the meeting, from the parent Section in Montreal. In addition to Mr. Thomas, other honor guests were J. P. R. Cristel, Chairman of the Montreal Section, Douglas MacMackin, Chairman of the Maritime Chapter, and several officers from the Montreal Section. Gifts to commemorate the occasion and express the good will of other Canadian Sections were presented from the Montreal Section, Toronto Section and Ottawa Chapter. The traditional gavel donated by the next youngest Chapter is scheduled to come from the Chinook Chapter in Calgary, and will be officially presented at the first Fall meeting.

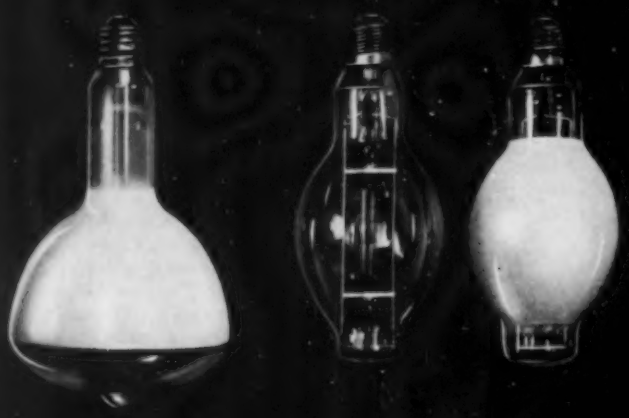
RLM Announces Publication Of News Letter Service

A new RLM service for those interested in industrial lighting standards and developments concerning them is announced by the RLM Standards Institute, Inc., 326 W. Madison Street, Chicago, Ill. Issued under the direction of the Technical Committee of the RLM Standards Institute, headed by Charles

(*Continued on page* 23A)

FLUORESCENT: over 290 different lamps for business and industry

MERCURY: 62 types from 85 through 3,000 watts



New economy and efficiency in industrial and commercial lighting

Westinghouse Job-

Now you can have exactly the right *kind* of lamp in exactly the right *size* for every individual lighting job

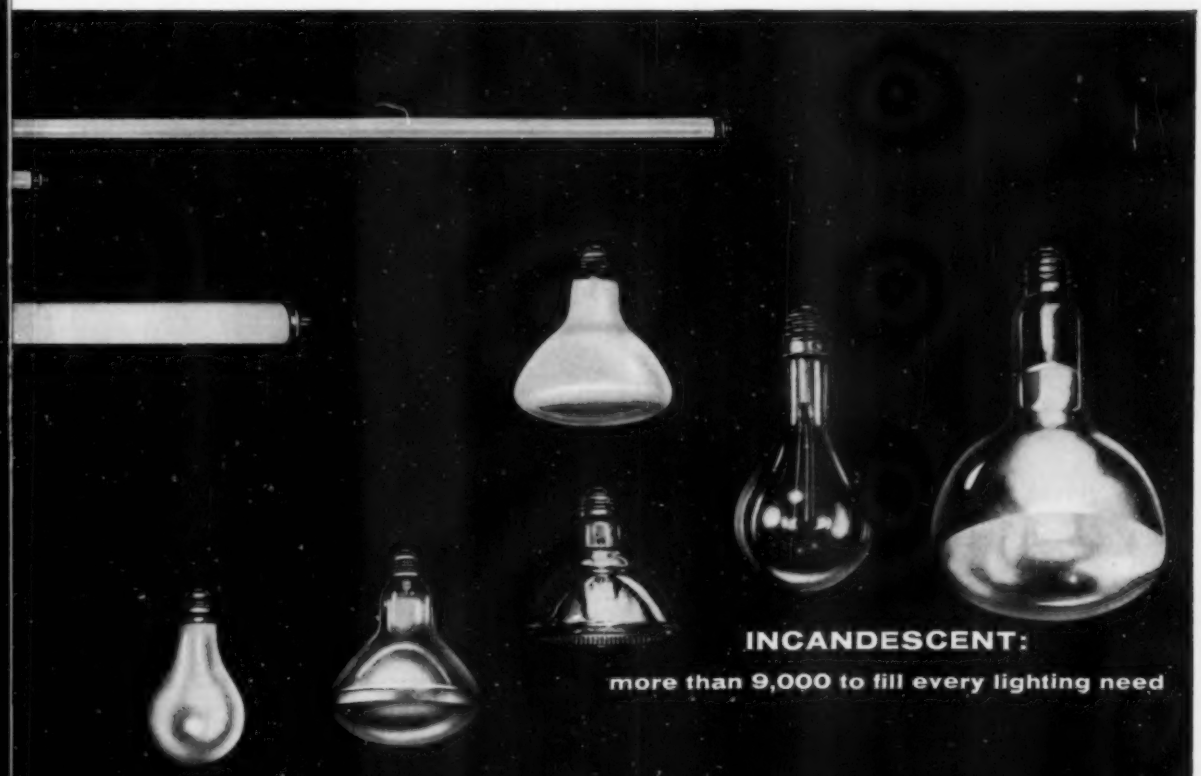
Westinghouse again demonstrates its leadership in lighting with lamps *Job-Tailored* to cut costs, reduce accidents, improve both "See-Ability" and morale. All this is possible because Westinghouse produces more than *10,000 kinds of lamps* with exclusive developments like those below which give you more for your lighting investment.

Fluorescent Lamps, for example, have a new high-intensity phosphor—*Ultralume*™—which gives more lumens per watt plus uniform end-to-end light for the life of the lamp.

Mercury Lamps with special "hard" glass *Weather Duty*™ construction. Can't be harmed by snow, rain, condensation—even without protective coverings.

Incandescent Lamps provide an extra measure of quality with exclusive *Lifeline Filament*™—made possible because only Westinghouse controls the manufacture of filaments from tungsten ore to finished wire.

In addition, Job-Tailored lamps give you more light from existing fixtures. By standardizing on bases, bulb sizes and light center lengths, Westinghouse provides a high degree of *lamp interchangeability*. As a result, with many Westinghouse lamps, you may increase light output to more efficient working and safety levels without changing fixtures.



Tailored Lamps

FREE WESTINGHOUSE JOB-TAILORED LIGHTING SURVEY SHOWS YOU HOW TO GET THE MOST FOR YOUR LIGHTING DOLLAR. To enable you to spot places in your present lighting installations where incorrect lamps may be costing you money, call in a Westinghouse Lamp Representative. With your plant engineer or maintenance supervisor, he will inspect your lighting installation, make a careful analysis of his findings, and report his recommendations. To get this free service, simply fill out the coupon. You'll be dollars ahead with Westinghouse JOB-TAILORED lighting.

YOU CAN BE SURE... IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
Industrial-Commercial Lighting Service
Bloomfield, New Jersey

Please have your Lamp Representative in my area make an appointment with our Mr. _____ to arrange a survey of our lighting needs.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ **ZONE** ____ **STATE** _____

FULL NAME OF PLANT ENGINEER _____

PHONE NUMBER _____

I am interested in ☐ incandescent ☐ fluorescent ☐ mercury lighting.

Here are the facts...

about a new approach to

LUMINOUS CEILINGS

Send for your copy NOW
and find out why
I·L·C provides far more
EFFICIENCY
ECONOMY
ARCHITECTURAL HARMONY

FILL OUT AND CLIP COUPON • MAIL TO—

SILVRAY LIGHTING, INC., RKO BLDG., RADIO CITY, N. Y.

Dear Sirs:

Will you kindly, without any obligation on my part, send me the ILC Booklet #S-457 with complete data on Indirect Luminous Ceilings.

NAME:_____

ADDRESS:_____

CITY:_____ STATE:_____

SILVRAY
LIGHTING, INC.
AND ASSOCIATED COMPANIES
RKO Bldg., Radio City, N. Y.

(*Continued from page 19A*)

L. Amick, the Institute will publish periodically a news letter covering news of developments in standards, new specification announcements, progress reports, etc. The number one issue now being released to architects, consulting engineers, electrical contractors, electrical distributors, lighting specialists, etc. covers such items as the forthcoming RLM specification covering fluorescent lighting units for the 800 milliampere lamps and the recommendations for increase in the efficiency of light output on the SD-1 units. It is the intention of the Institute to place on the complimentary list all those who may be interested in the specification, installation or purchase of industrial lighting equipment. Requests for the Number One issue and for enrollment on the complimentary subscription list should be sent to the Editor, RLM Industrial Lighting News, Suite 818, 326 W. Madison Street, Chicago 6, Ill.

Sheboygan Members Host to Milwaukee Section

Is a Charter in the offing in Sheboygan? I.E.S. members there were hosts to a successful Extension Meeting of the Milwaukee Section, April 25. Total attendance, 119. Milwaukee members loaded two buses for the special trip and were met at the city limits by a delegation from Sheboygan.

Their evening's program included a guided tour through the plant of their brand new Sustaining Member, the R. A. Manning Company, and inspection of four prominent church lighting installations, followed by a social hour at the Sky Room, with the Manning Company as host. During dinner, a certificate of Sustaining Membership was presented to Mr. Roland Manning. A representative of the Sheboygan Chamber of Commerce welcomed the I.E.S. and presented each member with a one-pound summer sausage, a product of Sheboygan.

Speaker of the evening was Mr. Alfred Siewert, Milwaukee architect, who spoke on "What the Architect Expects of the Lighting Profession in Church Architecture."

Illumination Courses Sponsored By Eastern Pennsylvania

The Eastern Pennsylvania Section of I.E.S., in cooperation with Penn State University has just completed a course in Illumination, covering fundamentals and application. The course was designated by the University as I.E. 992.

The two-hour sessions were held one night a week for 12 weeks at Reading and Allentown — Tuesdays at Reading, and Wednesdays at Allentown. The course was planned and supervised by regular representatives of the Extension Service of Penn State and student enrollment was secured by the I.E.S. Section. There were a total of 19 students in each of the classes.

Specialists were invited to lecture, coming from Philadelphia, New York and Central New York as well as the local Section.

Student reaction to the course was such that they have asked the University to sponsor an Advanced Course next year.

New Techniques Subject of Lamp and Lighting Forum

A rather novel Forum meeting was held in Cincinnati May 20, sponsored by the Ohio Valley Section of I.E.S. It packaged within one all-day meeting as much information as possible on new light sources and their applications, and new lighting techniques. The program also aimed at the wide-spread hunger for up-to-date information on fluorescent and mercury ballasts. For local lighting people, architects, consulting engineers and contractors, 131 of whom attended, the meeting was felt to be especially valuable.

Program chairman and organizer for this unique Forum was George H. Seiter of the Cincinnati Gas and Electric Company. Starting in mid-afternoon, the Forum recessed at 5:30 for a buffet supper, continuing again at 6:30 and throughout the evening. Included in this educational project were discussions on:

Lamps — Incandescent, D. R. Phillips, General Electric Co.
Fluorescent, Leo Duval, Sylvania Electric Products Inc.
Mercury, A. Paulus, Westinghouse Electric Co.
Discussion included types, characteristics and performance, and outdoor operation.

Ballasts — Fluorescent and Mercury Ballasts, M. E. Robertson, Jefferson Electric Company. Story of types, characteristics and performance of fluorescent and mercury ballasts.

Lighting Trends — An Architect's View on Lighting, Frederic H. Kock, Cincinnati Architect.
New Designs and Trends in Lighting, Eric H. Church, Lighting Products, Inc.

Round Table Discussion — Written questions, lively discussion.

(*Continued on page 24A*)

MILWAUKEE Section's annual Extension meeting traveled en mass to Sheboygan, Wisconsin, April 25. Attendance totaled 119. At right Chairman William N. Lisch thanks main speaker, Alfred Siewert, architect.

Applied Lighting Course Dallas, Texas

An 18-lesson, eight-week Applied Lighting Course was completed recently in Dallas, sponsored by the Southwestern Section with I.E.S. members forming the highly specialized faculty. Final statistics on the course point to an exceptionally successful project. Of the 82 students registered, over 90 per cent attended at least six of the eight meetings. The "student body" included 30 electrical contractors; 20 electrical suppliers; 17 utility employees; 10 manufacturers' representatives; 3 architects and 2 from industrial management.

Following the course, all those who had completed it were guests of the Section at its May meeting. Certificates were presented, and they were urged to continue their interest in lighting by joining the I.E.S. Principal speaker at this meeting was George F. Harrell, prominent Dallas architect, who spoke on "Lighting Beyond the Footcandle." Mr. Harrell stressed the importance of the I.E.S. principles relating to quality of a lighting system, especially with the new higher footcandle installations. The group was also addressed by C. W. Tatum, President of Dallas Power and Lighting Company, who praised their initiative in using their own time to further their education.

GRADUATES and instructors of the successful course in Applied Lighting recently completed by the Southwestern Section. Registration was 82 for the eight-week course.

I.E.S. Officers Elected For Year 1957-1958

At a meeting of the I.E.S. Council held June 12, 1957, the report of the Committee of Tellers was presented, giving the results of the recent election of officers for the coming year, beginning October 1, 1957. The following have been elected to the offices indicated.

General Officers

President — K. M. Reid, General Electric Co., Nela Park, Cleveland, Ohio.
Vice-President — J. B. Browder, Georgia Power Co., Atlanta, Ga.
General Secretary — R. G. Slauer, Sylvania Electric Products Inc., Wheeling, W. Va.
Treasurer — J. R. Chambers, Appleton Electric Co., Chicago, Ill.
Directors (Until 1960) — J. D. Mitchell, Westinghouse Lamp Division, Chamblee, Ga.; J. D. Whitnell, Arizona Public Service Co., Phoenix, Ariz.
Regional Vice-Presidents — Canadian Region, J. C. Wilson, J. A. Wilson Lighting & Display, Ltd., Toronto, Ont.; *East Central Region* — C. C. Shotwell, Philadelphia Electric Co., Philadelphia, Pa.; *Inter-Mountain Region*, A. E. Fleming, General Electric Supply Co., Salt Lake City, Utah; *Southeastern Region*, James A. Banton, Tampa Electric Co., Tampa, Fla.; *Southwestern Region*, R. K. Lothrop, Southwestern Gas & Electric Co., Shreveport, La.

Alabama Section

Chairman — J. T. Keyser, Jr., Alabama Power Co., Birmingham, Ala.
Vice-Chairman — W. C. Martin, Jr., Alabama Power Co., Birmingham, Ala.
Secretary — Sam Davidson, Alabama Power Co., Montgomery, Ala.
Board of Managers — Ralph Bynum, W. J. Broughton, D. G. Hallmark, A. S. Shook.

Alamo Section

Chairman — W. G. Darley, 164 USAA Bldg., P. O. Box 6743, San Antonio, Texas.
Vice-Chairman — J. C. Faglie, Box 7246, Hackberry Station, San Antonio, Texas.
Secretary — R. W. Barnes, Rt. #2, Box 279, San Antonio, Texas.
Board of Managers — K. L. Cotton, H. R. Halsey, M. G. Simons, R. G. Turpin.

Arizona Section

Chairman — J. R. Williams, Arizona Public Service Co., Phoenix, Ariz.
Vice-Chairman — R. E. Tweedy, 914 W. Madison St., Phoenix, Ariz.
Secretary — R. W. Goodmann, Arizona Public Service Co., Phoenix, Ariz.
Board of Managers — L. B. Carlson, P. F. Douty, F. M. Gasperak, Rosa Hendrix.

British Columbia Section

Chairman — P. F. Fletcher, Canadian General Electric Co., Ltd., Vancouver, B. C.
Vice-Chairman — E. N. Kolbeins, Associated Consulting Engineers, Vancouver, B. C.
Secretary — H. G. Foster, Northern Electric Co., Ltd., Vancouver, B. C.
Board of Managers — A. M. Anderson, J. N. Bodel, F. G. Crompton, J. B. Walker.

Capital Section

Chairman — S. W. Charlesworth, General Electric Supply Co., Washington, D. C.
Vice-Chairman — Alfred J. Rugo, Sylvania Electric Products Inc., Alexandria, Va.
Secretary — E. F. Bailer, 3518 Farthing Drive, Silver Spring, Md.
Board of Managers — K. W. Cobb, R. M. Lowry, J. A. McNeal, H. V. Oerting.

Central New York Section

Chairman — J. J. McVey, Niagara Mohawk Power Co., Syracuse, N. Y.
Vice-Chairman — John S. Haney, Crouse-Hinds Co., Syracuse, N. Y.
Secretary — Robert Caryl, Donohue & Caryl, Syracuse, N. Y.
Board of Managers — C. F. Cottrell, D. M. Esthus, J. G. Headley, E. L. Moyer.

Chicago Section

Chairman — W. F. Carson, Commonwealth Edison Co., Chicago, Ill.
Vice-Chairman — J. J. McLaughlin, Kelso Burnett Electric Co., Chicago, Ill.
Secretary — C. W. Clarkson, Corning Glass Works, Chicago, Ill.
Board of Managers — B. J. Avery, E. H. Church, E. H. Gallet, L. H. Van Dermark, Jr.

Cleveland Section

Chairman — R. W. Morris, General Electric Co., Nela Park, Cleveland, Ohio.
Secretary — L. S. Sternberg, Pittsburgh Reflector Co., Cleveland, Ohio.
Board of Managers — C. J. Allen, L. O. Banahan, Norman Falk, W. H. Johnson, A. H. Stevenson, Jr.

Connecticut Section

Chairman — R. D. Babcock, General Electric Co., New Haven, Conn.
Vice-Chairman — H. R. Young, Litecontrol Corp., Watertown, Mass.
Secretary — W. P. Carpenter, The Superior Electric Co., Bristol, Conn.
Board of Managers — R. H. Chase, Merritt Horner, J. J. Neidhart, W. E. A. Richards.

Cornhusker Section

Chairman — Mark E. Lee, Iowa Public Service Co., Sioux City, Iowa.
Vice-Chairman — Ford E. Foster, 1006 N. 20th St., Omaha, Nebr.
Secretary — Merle Burris, Jr., Iowa Public Service Co., Sioux City, Iowa.
Board of Managers — W. J. Cook, E. C. Knudson, H. J. Palmer, Jr., W. M. Scholes.

Eastern New York Section

Chairman — J. R. Hartman, American Locomotive Co., Schenectady, N. Y.
Vice-Chairman — John S. Baker, Westinghouse Electric Corp., New York, N. Y.
Secretary — John M. Harney, Smith Electric Co., Inc., Cahoes, N. Y.
Board of Managers — S. E. Middlebrooks, G. C. Mills, J. L. Ottenheimer, G. F. Rancourt.

Eastern Pennsylvania Section

Chairman — E. H. Kelsey, Pennsylvania Power & Light Co., Harrisburg, Pa.
Vice-Chairman—Richard J. Pretzman, Raub Supply Co., Lancaster, Pa.
Secretary — J. R. Fritz, Gilbert Associates, Inc., Reading, Pa.
Board of Managers — R. M. Hauer, J. L. Medlar, R. A. Reynolds, G. E. Solley.

Florida Section

Chairman — R. L. Sirmons, Florida Power Corp., Clearwater, Fla.
Vice-Chairman — M. L. Harkey, Jr., General Electric Co., Tampa, Fla.

(*Continued on page* 27A)

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*John E. Artopoeus of Artopoeus-Smith Company, Northern Ohio representatives, one of Smithcraft's nationwide sales-engineer organization.

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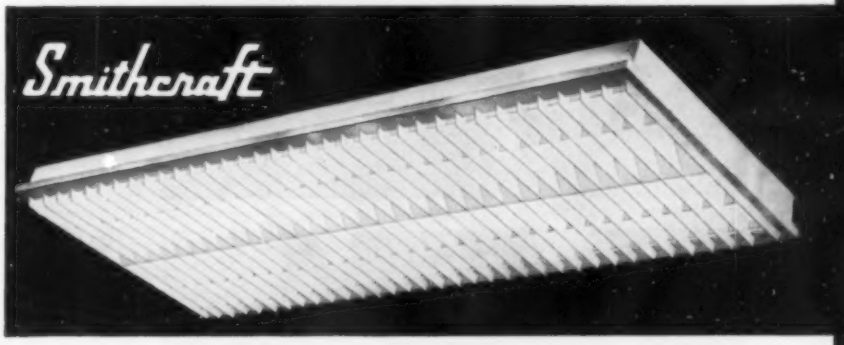

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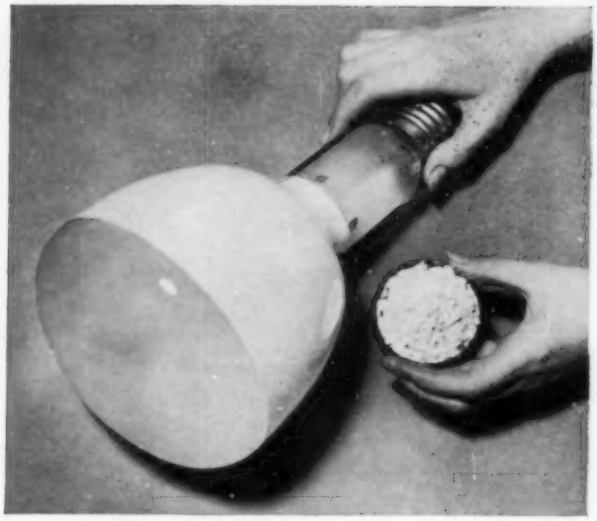
Which of these 3 new General Electric Lamps solves your problem?



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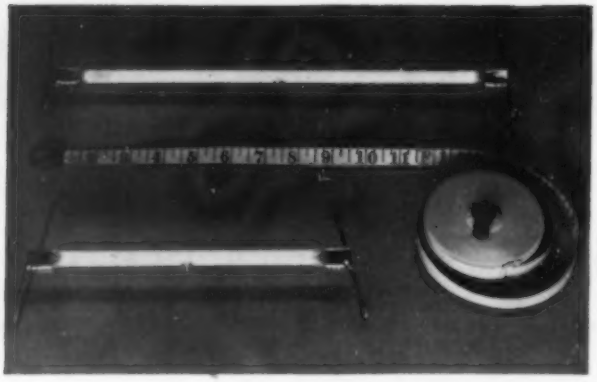
G-E "POWER-GROOVE". Planning any new lighting? New General Electric "Power-Groove" fluorescent lamps give you nearly double the light of High-Output fluorescents . . . 2½ times as much as 8-foot Slimlines. Save 5% to 20% of your initial cost and have fewer parts to maintain. General Electric "Power-Groove" Lamps are Rapid Start lamps that need no starters—and are to be used in fixtures and circuits designed especially for them. If you're planning new lighting, investigate G-E "Power-Grooves". Several manufacturers now have fixtures available.



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(*Continued from page 24A*)

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Board of Managers — E. A. Bartlett, C. E. McCormick, H. L. Rhodes, W. B. Shenk.

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Vice-Chairman — Thomas W. Haslam, Georgia Power Co., Atlanta, Ga.
Secretary — S. J. Andre, Georgia Power Co., Atlanta, Ga.
Board of Managers — John Brun, J. J. Burns, P. E. Newman, W. M. Pearson.

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Vice-Chairman — John E. Keyes, Benjamin Electric Mfg. Co., San Francisco, Calif.
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Board of Managers — George M. Baker, J. E. Barnes, Guy De Leuze, H. A. Wright.

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Board of Managers — H. B. Ewert, F. I. Feagans, F. E. Miles, F. L. Taylor, N. J. Thompson.

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Vice-Chairman — N. J. Reinhart, Peerless Electric Supply Co., Indianapolis, Ind.
Secretary — Pierce Eckhart, General Electric Co., Indianapolis, Ind.
Board of Managers — H. W. Claffey, Denton Hall, N. F. Schnitker, Donald Weir.

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Secretary — Mrs. Mary Stafford, Thomas Electric Co., Des Moines, Iowa.
Board of Managers — W. D. Barnhizer, L. J. Widigen, G. L. Williams, W. L. Yarger.

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Vice-Chairman — Paul J. Puckett, Westinghouse Electric Corp., Baltimore, Md.
Secretary — J. D. Smith, General Electric Co., Baltimore, Md.
Board of Managers — J. C. Burdette, Jr., M. E. Gillespie, C. E. Sparrow, Jr., H. M. White.

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Secretary — C. C. Munroe, Jr., Edwin F. Guth Co., 25741 Kennedy Drive, Dearborn, Mich.
Board of Managers — Adriaan Van Oss, E. W. Pratt, Duncan Preston, G. S. Thornton, M. V. Westrick.

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Vice-Chairman — M. H. Bruesewitz, Wisconsin Electric Power Co., Milwaukee, Wis.
Secretary — R. L. Wittenberg, Herman Andrae Electrical Co., Milwaukee, Wis.
Board of Managers — R. R. Cheney, W. N. Lisch, Robert J. Present, Edwin Schnoll.

MONTREAL SECTION

Chairman — W. P. Beasley, Northern Electric Co. Ltd., Montreal, Que.
Secretary — Gordon Nako, Mitchell Mfg. Co., Ltd., Montreal, Que.

1958 Regional Conferences, I.E.S.

Region	Place	Date
Northeastern	Statler Hotel Hartford, Conn	April 10-11
East Central	Richmond, Virginia	April 14-15
South Central and Southeastern	Lafayette Hotel Little Rock, Arkansas	April 24-25
Southwestern	Shreveport, La.	April 28-29
Midwestern	Hotel President Kansas City, Mo.	May 1-2
Inter-Mountain	Pueblo, Colorado	May 8-9
South Pacific	El Cortez Hotel San Diego, Calif.	May 14-15
Pacific Northwest	Multnomah Hotel Portland, Oregon	May 22-24
Great Lakes	Sheraton Hotel Rochester, N. Y.	June 23-24

Board of Managers — F. W. Fulle, V. Labbe, Yven Montcalm, J. E. Shepherd, J. M. Wickett.

NEW ENGLAND SECTION

Chairman — Walter L. Ball, Stone & Webster Engineering Corp., Boston, Mass.
Vice-Chairman—Edward O. Kaasman, Westinghouse Electric Corp., Boston, Mass.
Secretary — John Carr, General Electric Co., Boston, Mass.
Board of Managers — L. A. Bean, J. F. G. Eichorn, Ralph Huse, Paul Lamson.

NEW ORLEANS SECTION

Chairman — Walter T. Faber, Louisiana Power & Light Co., New Orleans, La.
Vice-Chairman — Charles C. Kleinschmidt, P. O. Box 843, New Orleans, La.
Secretary — G. A. Segal, New Orleans Public Service Co., New Orleans, La.
Board of Managers — G. E. Brown, S. H. Nothacker, G. C. Schroeder, Jr., J. A. Stelly.

NEW YORK SECTION

Chairman — Herbert A. Anderson, Duro-Test Corp., North Bergen, N. J.
Vice-Chairman — Robert L. Zahour, Westinghouse Electric Corp., Bloomfield, N. J.
Secretary — J. W. Hamilton, Day-Brite Lighting, Inc., New York, N. Y.
Board of Managers — W. H. Keen, Robert Levenstein, R. V. Smith, W. S. Till.

NORTH TEXAS SECTION

Chairman — Thomas L. Moore, Fischbach & Moore of Texas, Inc., Dallas, Texas.
Vice-Chairman — E. L. Cole, Dallas Power & Light Co., Dallas, Texas.
Secretary — W. T. Kimery, Dallas Power & Light Co., Dallas, Texas.
Board of Managers — J. B. Deck, Jr., E. I. Dinsmore, D. S. Gallagher, L. V. Randle.

NORTHWESTERN OHIO SECTION

Chairman — John B. Cloer, The Toledo Edison Co., Toledo, Ohio.
Vice-Chairman — Richard J. Gross, Gross Electric Co., Toledo, Ohio.
Secretary — Paul B. Hood, Eggleston & Son, Toledo, Ohio.
Board of Managers — Lyle Cole, Homer Ferguson, Walter Ruehlin, W. H. Teel, Jr.

OHIO VALLEY SECTION

Chairman — V. G. McClusky, General Electric Co., Cincinnati, Ohio.
Secretary — F. B. MacRae, The Miller Co., Cincinnati, Ohio.
Board of Managers — L. P. Cohron, D. T. Ostrander, R. A. Rostek, Ruth C. Rutterer, P. F. Stiller.

OIL CAPITAL SECTION

Chairman — W. T. Walters, Public Service Co. of Oklahoma, Tulsa, Okla.
Vice-Chairman — J. C. Netherton, Jr., 3130 E. 44th St., Tulsa, Okla.
Secretary — R. Almond, Almond Electric Co., Tulsa, Okla.
Board of Managers — C. H. Dollmeyer, J. H. Rauch, J. R. Seay, T. C. Wier.

OREGON SECTION

Chairman — Jack Cottingham, Portland General Electric Co., Portland, Ore.
Vice-Chairman — Delbert W. Shirley, Oregon State College, Corvallis, Ore.
Secretary — John Schulter, Sunbeam Lighting Co., Portland, Ore.
Board of Managers — Garland Barlogi, Fred Farley, Jerry Miller, Dwayne Seely.

PHILADELPHIA SECTION

Chairman — R. R. Enghouser, Sylvania Electric Products Inc., Philadelphia, Pa.
Vice-Chairman — Thomas O. Broussard, Westinghouse Electric Corp., Philadelphia, Pa.
Secretary — W. P. Graham, Philadelphia Electric Co., Philadelphia, Pa.
Board of Managers — Edwin H. Henrie, V. W. Kafka, David D. Lees, H. A. Williams.

PITTSBURGH SECTION

Chairman — James A. Hodges, James A. Hodges Co., Pittsburgh, Pa.
Vice-Chairman — John S. Frizzell, Pittsburgh Reflector Co., Pittsburgh, Pa.
Secretary — W. A. Eisenhower, 238 West Carson St., Pittsburgh, Pa.
Board of Managers — J. F. Boyden, Jr., L. W. Hornfeck, J. B. McNall, D. C. Thomas.

PUGET SOUND SECTION

Chairman — John O. Berg., B. A. Travis & Associates, Seattle, Wash.
Secretary — J. H. Wells, B. T. Heinz Co., Seattle, Wash.
Board of Managers — H. C. Hall, H. R. Huber, R. E. Jones, E. A. Matlock, C. I. Page.

ROCHESTER SECTION

Chairman — Fred Schmidt, Graybar Electric Co., Inc., Rochester, N. Y.
Secretary — W. H. Louden, Rochester Gas & Electric Corp., Rochester, N. Y.
(*Continued on page 28A*)

(*Continued from page 27A*)

Board of Managers — W. S. Barclay, A. G. Elley, N. J. Kridel, R. B. Thompson, F. Vanderlinde.

ROCKY MOUNTAIN SECTION

Chairman — Leigh Congdon, Rite Lite Supply Co., Denver, Colo.
Vice-Chairman — L. S. Reed, L. S. Reed Co., Denver, Colo.
Secretary — G. H. Patterson, General Electric Supply Co., Denver, Colo.
Board of Managers — L. J. Carlon, D. Q. Ford, J. H. McCulloch, C. O. Woodworth.

ST. LOUIS SECTION

Chairman — R. D. Cohen, Glasco Electric Co., St. Louis, Mo.
Vice-Chairman — Charles Zurheide, Smith, Hanlon, Zurheide, Levy Inc., St. Louis, Mo.
Secretary — Willis Mangold, General Electric Co., St. Louis, Mo.
Board of Managers — Brooks Chassaing, J. J. Rhoades, E. W. Stohlman, Jr., R. J. Welch.

SAN JACINTO SECTION

Chairman — Arthur Rice, Bernard Johnson & Associates, Houston, Texas.
Vice-Chairman — George Simpson, Graybar Electric Co., Houston, Texas.
Secretary — Richard Jung, General Electric Co., Houston, Texas.
Board of Managers — Jack Chrismer, Curt Grevelius, Sumner Harris, G. L. McGonigle.

SOUTHERN CALIFORNIA SECTION

Chairman — Roy E. Bevan, Sylvania Electric Products Inc., Los Angeles, Calif.
Vice-Chairman — Audie Ashcraft, Southern California Edison Co., Los Angeles, Calif.
Secretary — F. B. Lee, General Electric Co., Los Angeles, Calif.
Board of Managers — G. A. Hochenauer, J. R. Jones, P. F. O'Brien, H. I. Strahn.

TAR HEEL SECTION

Chairman — J. J. Cardo, Independent Electric Supply Co., Charlotte, N. C.
Vice-Chairman — James A. Lowe, Duke Power Co., Greensboro, N. C.
Secretary — T. L. Cordle, J. N. Pease & Co., Charlotte, N. C.
Board of Managers — P. C. Butler, E. C. Gatewood, S. B. Harper, G. C. Hough.

TENNESSEE VALLEY SECTION

Chairman — Harry Bourgeois, 1805 Hayes St., Nashville, Tenn.
Secretary — J. D. Harris, Nashville Electric Service, Nashville, Tenn.
Board of Managers — Joe Fowler, May L. Gale, J. B. Holt, Bill Roberts, J. Stansell.

TORONTO SECTION

Chairman — J. M. Chorlton, Toronto Board of Education, Toronto, Ont.
Vice-Chairman — E. Machtinger, Crouse-Hinds Co., Toronto, Ont.
Secretary — R. P. Lindsay, Canadian Line Material Inc., Toronto, Ont.
Board of Managers — A. J. Brown, W. A. Dalrymple, A. W. Henschel, K. Tate.

TWIN CITY SECTION

Chairman — G. W. Frederick, General Electric Co., Minneapolis, Minn.
Vice-Chairman—Francis T. Tillemans, Westinghouse Electric Corp., Minneapolis, Minn.
Secretary — J. C. Newhouse, Northern States Power Co., Minneapolis, Minn.
Board of Managers — A. A. Aronson, John Bahnak, G. P. Ellison, E. H. Voss.

UTAH SECTION

Chairman — F. C. Bates, Bates Engineering Co., Salt Lake City, Utah.
Vice-Chairman — J. W. Lowder, Stevens Sales Co., Salt Lake City, Utah.
Secretary — R. C. Evans, 110 Social Hall Ave., Salt Lake City, Utah.
Board of Managers — Ernest Forsberg, W. A. Huckins, Jr., H. R. Tripp, C. J. Vacher.

WESTERN MICHIGAN SECTION

Chairman — D. A. Harper, General Electric Supply Co., Grand Rapids, Mich.
Vice-Chairman — William Winglar, J. & G. Daverman Co., Grand Rapids, Mich.
Secretary — L. L. Nurnberger, Consumers Power Co., Traverse City, Mich.
Board of Managers — Kenneth Gelders, R. C. Graham, Ray McGuire, J. Q. Miller.

WESTERN NEW YORK SECTION

Chairman — L. P. Gauthier, Sylvania Electric Products Inc., Buffalo, N. Y.
Secretary — William P. Ackendorf, Niagara Mohawk Power Corp., Buffalo, N. Y.
Board of Managers — T. E. Barhite, Jr., F. B. Burke, W. E. Hayes, Neal Jacobus, B. F. Lyth, Jr.

Edmonton Chapter Completes Successful Lighting Course

The relatively youthful I.E.S. Chapter in Edmonton, Alberta undertook and successfully completed a Section-size project recently in its eight-weeks Illumination Course. Some 63 local engineers and architects registered for the course which consisted of eight lectures as follows:

Theory of Light — Ron Phillips
Illumination Terms — Ron Phillips
Lamps — Fred Dorward
Industrial Lighting — Art Baragon
Wiring — Art Neilson
Illumination Designs — John Morgan
Office and School — Gordon Raisbeck
Store Lighting — Ron Vernon
Economics — Bruce Allsopp
Exterior and Residential — John Morgan and Fred Dorward.

Students completing the course were honored at a special Ladies' Night Evening and dinner held at the Hillcrest Country Club, Edmonton, where certificates of attendance were presented to those meeting the attendance requirements.

In view of the enthusiasm with which this year's students received the course, the Chapter plans to repeat it in the Fall.

ABOUT PEOPLE

James R. Chambers, formerly with Benjamin Electric Manufacturing Company, Des Plaines, Illinois, and currently Treasurer-elect of I.E.S., has joined the Appleton Electric Company, Chicago, Illinois, as Sales Manager of the company's Lighting Division.

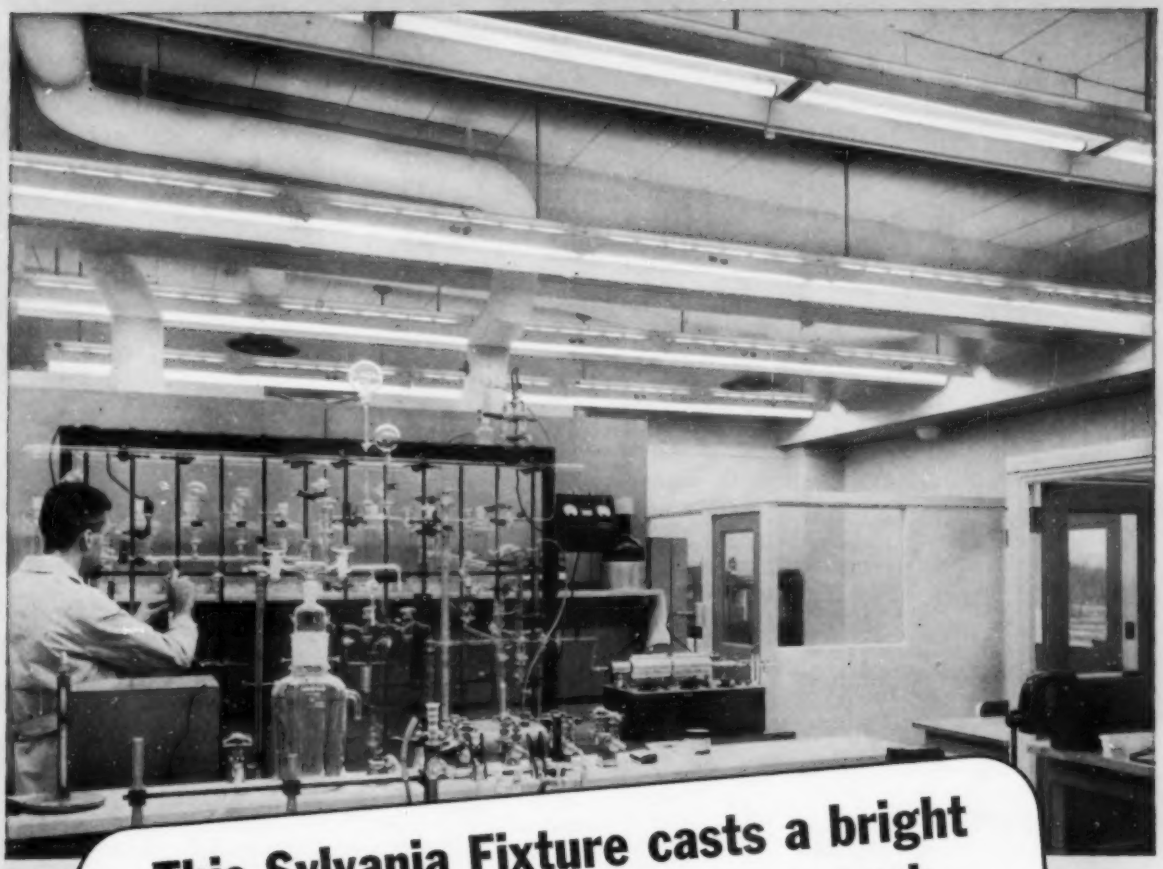
A new sales district has been established by Westinghouse in the north Los Angeles area. Heading the new office will be **Willard C. Hird,** it has been announced. **Raymond K. Leonard,** formerly manager of the Los Angeles sales district from which the new district was developed, will manage the newly created south Los Angeles sales district.

R. L. Biesele, Jr., formerly professor of electrical engineering at the University of Oklahoma, Norman, Okla., and Southern Methodist University, Dallas, recently assumed the position of Chief Servo Engineer of Fenwal, Inc., Ashland, Massachusetts. The company operates in the field of temperature measurement and control and infrared detection.

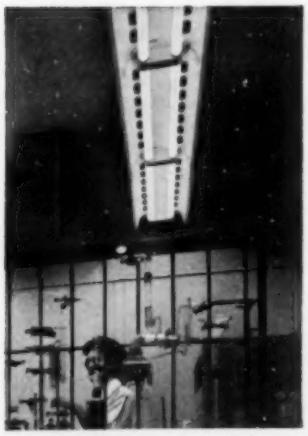
General Electric Company Large Lamp Department has announced several new district sales managers. **James W. Billings** has been named Pacific Sales District Manager for the company's San Francisco office. In his new post, Mr. Billings succeeds **Donald D. Scarff.** For the past two years Mr. Billings was a district manager for the Photo Lamp

(*Continued on page 30A*)

ABOUT half the registrants in the Edmonton Chapter course on Fundamentals of Illumination.



This Sylvania Fixture casts a bright new light on scientific research ... for this large industrial manufacturer



Upward light component on Sylvania NTWS fixtures means more and better light on the job. Reflector slots also induce lamp-cleaning upward "chimney" draft.

For over half a year, Sylvania NTWS industrial lighting fixtures have been on the job at the new physics research laboratories of one of the country's largest industrial firms.

These semi-direct lighting units maintain the high 70-80 footcandle levels needed for critical seeing tasks, in studying the electrons which surround the atomic nucleus, in developing a long list of new products based on these studies.

Spearheading new trends in industrial lighting, Sylvania NTWS fixtures deliver a full 10% upward light component through slots in reflectors. This increases illumination efficiency and total light output. *It mellows harsh overhead contrasts ... softens eye-straining shadow and glare spots at working level.*

"The Sylvania fixtures were selected because they met specifications set forth by our General Engineering Department, at a realistic price," reports an engineering representative from these laboratories. "In 8 months of use, there has been no drop in efficiency, no repairs have been required, and lamp replacement is rapid and easy."

For expert lighting assistance, contact the Sylvania Fixture Specialist in your area. And write direct for our *free* new helpful booklet No. V-501, "*Prescribed Lighting Protects the Eyes of Industry.*"

SYLVANIA ELECTRIC PRODUCTS INC.
Dept. G30, Lighting Division—Fixtures
One 48th Street, Wheeling, W. Va.

SYLVANIA

fastest growing name in sight

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

(*Continued from page 28A*)

Department with offices in Atlanta, Georgia.

In the Michigan Sales District of General Electric in Detroit, **Ted P. Brown** has been appointed district manager, succeeding **Earl A. Anderson** who retired July 1 after nearly 44 years of service with the company.

Robert J. Diefenthaler has been named Chicago Sales District Manager of General Electric. In his new post, Mr. Diefenthaler succeeds **Frederick F. Denny** as district manager.

The new Florida Sales District Manager for General Electric will be **D. Jefferson Faulkner, Jr.,** succeeding **Douglas B. Clark.**

For the New York Sales District of General Electric, **Paul H. Ganther** has been appointed district manager, with offices in New York City.

Robert F. Herzer has been named Indiana Sales District Manager for G. E. Mr. Herzer succeeds the late **John R. Colville, Jr.,** in this post.

George Albiez, president of Englewood Electrical Supply Co., Chicago, was elected president of the National Association of Electrical Distributors at its 49th Annual Convention, in Washington, D. C. Mr. Albiez succeeds **Ralph J. Brown,** marketing manager for the General Electric Supply Co., Bridgeport, Conn., who becomes a director.

A new consulting firm of **R. D. Burnham** and Associates has been established in Vermilion, Ohio, headed by Robert D. Burnham, formerly with The Wakefield Lighting Company.

The Miller Company, Meriden, Conn., has announced the appointment of **William I. Vawter, Jr.,** as sales representative for George and Jackson County in Alabama. Mr. Vawter will work out of Atlanta in a combined sales effort with **Charles L. Woodyard.**

Oscar P. Cleaver of the U. S. Army Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va., has been honored as the first Army employee chosen to attend the Executive Development Program at Cornell University. Chief of the Electrical Engineering Department at the Laboratories, he was one of 40 selected executives from business and government to attend the program which began June 16, and extends to July 27.

Thomas B. Turner has been named product planning specialist at the General Electric Ballast Department according to an announcement by E. C. Schorr, manager of marketing for the department.

Crouse-Hinds Company, Syracuse, N. Y. has announced the appointment of **Gordon Van Dyke Miller** as divisional manager of the company's Philadelphia Sales Division. In his new post, Mr. Miller replaced **Charles Knox, Jr.,** whose retirement was announced June 1.

A new Marketing Department has been announced for the John C. Virden Company, Cleveland, Ohio. The new department will be headed by **Robert W. Minett, Jr.,** Director of Marketing, and will include **C. L. Smythe, Alex E. Masterson** and **E. A. Pacius.**

Willard C. Brown, Manager of Application Engineering for the General Electric Company, has been elected president of the Cleveland Engineering Society. He succeeds **Warren H. Chase,** vice-president of the Ohio Bell Telephone Company who served two terms as president and is a member of the Board.

George S. Evans has been named manager of fluorescent lamp engineering for the Westinghouse Electric Corp. In his new position, Mr. Evans will be in charge of all fluorescent design and development engineering for Westinghouse, in Bloomfield, N. J. Prior to the appointment Mr. Evans was district lamp sales manager in Detroit.

William G. Darley, consulting engineer and chairman-elect of the Alamo Section of I.E.S. has announced the opening of his new consulting office at 164 USAA Building, San Antonio, Texas. Mr. Darley, a Fellow of I.E.S., formerly was a consulting engineer in Austin, Texas.

George N. Hawley, vice--president of Southern California Edison Company has been elected president of the Pacific Coast Electrical Association. He and 12 directors were elected at the concluding session of the association's 40th annual convention in San Francisco, May 15-17.

Lester E. Barrett, president of Barrett Electric Supply Co., St. Louis, Mo., received the Distributors Medal and Purse, given under the James H. McGraw Award for Electrical Men, at the annual meeting of the National Association of Electric Distributors in Washington, D. C., May 28. Mr. Barrett received the award for his leadership and influence in encouraging the active participation of his fellow distributors in forwarding the broad goals of adequate wiring nationally and locally.

Guy C. Rhoad has been named vice-president in charge of manufacturing of the Gibson Manufacturing Company, Atlanta, Georgia. Mr. Rhoad joined the Gibson organization in 1950 as design engineer and has headed the firm's design department since that time.

Chuck Bacon has been appointed Sales Engineer and representative for Leadlight Fixture Company, Oakland, California, according to an announcement from Milton Kosman, president. He will make his headquarters in Sacramento, California, with offices in the Builders Exchange.

The American Institute of Electrical Engineers has elected **Walter J. Barrett,** of Glen Ridge, N. J., as its 1957-1958 president. Announcement was also made of the election of five vice-presidents, three directors, and a treasurer.

Robert B. Cullum has been named a director of Dallas Power and Lighting Company, and **P. M. Rutherford,** long an active member of I.E.S., has been named Vice-President and Commercial Manager.

Newly appointed representative for Day-Brite Lighting, Inc., west coast branch, will be **William Benndorf** of Phoenix, Arizona. Mr. Benndorf will represent Day-Brite for the state of Arizona.

Sunbeam Lighting Company, Los Angeles, has announced the acquisition of the 4½-acre Reynolds Metal Company plant at Gary, Indiana. The new facility, to be designated Sunbeam Lighting Company, Inc., Eastern, is expected to be in operation by about July 1st. Officers will be **Herbert L. Krieger,** Chairman of the Board, **Phil R. Freeman,** President, **Mac Bodian,** Vice-President, and **Irving Weisbart,** Vice-President.

Charles I. Brady, Jr., Metropolitan (N. Y.) District Lighting Sales Manager of Sylvania Electric Products Inc., has been awarded the Field Sales Management Award of the National Sales Executives at the NSE's 22nd annual International Distribution Congress, Los Angeles. The award was established three years ago by the Board of Directors of the National Sales Executives Inc., which is a non-profit organization of 30,000 members and 210 sales executives clubs located in North and South America, Europe, Africa, Australia, and the Philippines.

Andrew Genor has been assigned to a field position by Line Material Industries. He will headquarter at Spokane, Washington to serve as lighting engineer in the company's Mountain States Division.

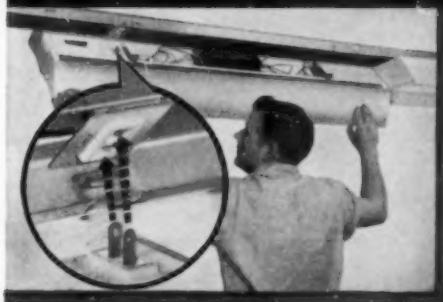
(*Continued on page 40A*)

ortho-88

Patent Pending

ALSO AVAILABLE IN COMMERCIAL DESIGN

ABSOLUTELY NOTHING LIKE IT FOR FAST INSTALLATION AND FLEXIBILITY



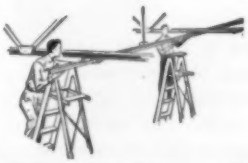
Snap—and It's Up. The inset shows how the plug built into the fixture automatically engages a receptacle in the Uni-Race. Simple hooks and latches fasten the fixture to the Uni-Race.

Contractors throughout the country report that a complete Gibson Ortho installation takes, on the average, only 22 man-minutes per fixture, including stems, lamping and mounting. That's just a fraction of the time required for conventional installations. But speedy installation is only part of the story. Consider the flexibility the owner enjoys. Ortho fixtures can be mounted in continuous rows or at intervals, and re-spaced at any time in a matter of minutes.

WRITE, WIRE OR CALL FOR COMPLETE INFORMATION

3 SIMPLE STEPS TO INSTALL THE ORTHO

1 Telescoping sections of Uni-Race assembled and wired on the floor.



2 Light but rigid Uni-Race assembly, up to 24', easily lifted and hung.

3 Fixtures snap into place in seconds without tools. No wired connection.

Patent Pending

Gibson LIGHTING

GIBSON Manufacturing Co.

1919 Piedmont Circle, N.E., Atlanta 9, Georgia

MAKERS OF THE NEW Ceilo • 35 WORLD'S THINNEST FIXTURE WITH NO DARK AREAS

IN CANADA manufactured under franchise by one of Canada's oldest and largest manufacturers of lighting fixtures ELECTROLIER MFG. CO. Ltd., Montreal

Kopp Flying Glassware

keeps pace with expanding air travel

"Can we depend on the glass?"

You certainly can when it's Kopp Glass. That's because Kopp is specifically designed and custom-made to provide optimum dependability and safety under the most severe service conditions.

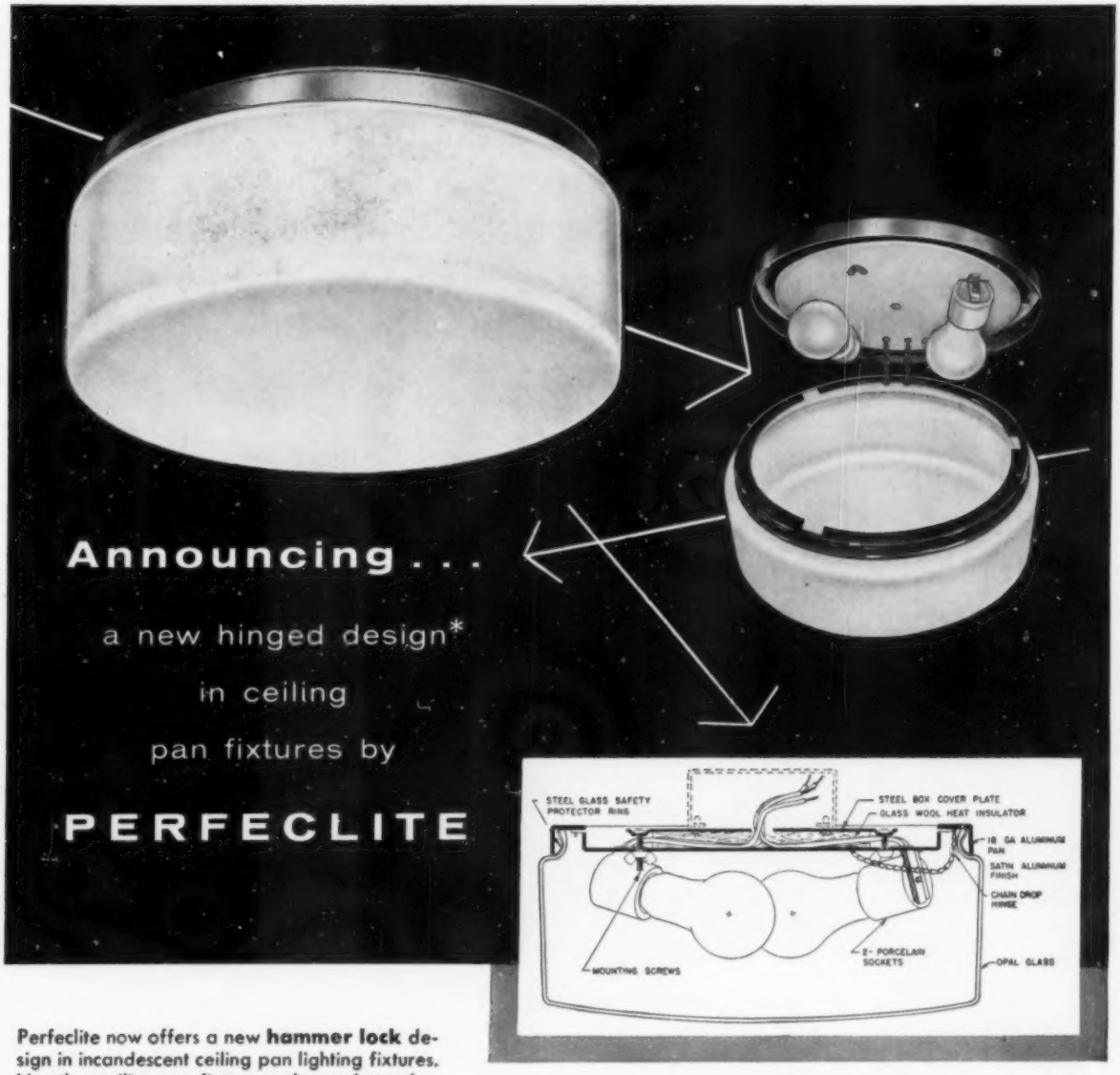
Kopp "flying" glassware is carefully engineered to give you the best in beam control, color transmission, weather resistance and any other desirable characteristic. An excellent service record both on airplanes and on airports has been the result.

But Kopp engineers aren't resting on these achievements. They're pressing forward relentlessly—piercing safety barriers—to improve existing products and develop new ones. Call today if you have a technical glass problem. Our engineering department will be glad to help you.

KOPP GLASS

KOPP GLASS, Inc.

Swissvale, Pennsylvania



Perfeclite now offers a new **hammer lock** design in incandescent ceiling pan lighting fixtures. No other ceiling pan fixture on the market today has all these engineering features:

- Globe opens on **hinge** for quick easy cleaning and relamping.
- Unique **safety locking fitter** holds globe in place without bothersome screws, unsightly extensions or trick springs. Globe is secured with lugs by simple twist of the wrist.
- Lip of globe is completely protected against breakage by a **steel protector ring.**
- Provides **ceiling illumination** as well as **evenly distributed floor lighting.**
- Minimum amount of metal, maximum amount of glass results in **highest light efficiency.**

Here is a unique ceiling pan fixture design for either commercial or residential installation. For further information send for The Perfeclite Data Sheet 56-C today.

Perfeclite's new **hammer lock** fixture is available in the following sizes:

Model	Glass Diameter	Wattage
HH-9	8″	2- 40 W
HH-11	10″	2- 60 W
HH-13	12″	2- 75 W
HH-15	14″	2-100 W
HH-17	16″	3-100 W

Send for new Perfeclite Catalog 956 giving full information on our entire line of Commercial Incandescent Fixtures and Exit Units.

Fixtures are Underwriters Laboratories, Inc. approved.
*Patent pending

THE PERFECLITE COMPANY
1457 East 40th Street • Cleveland 3, Ohio

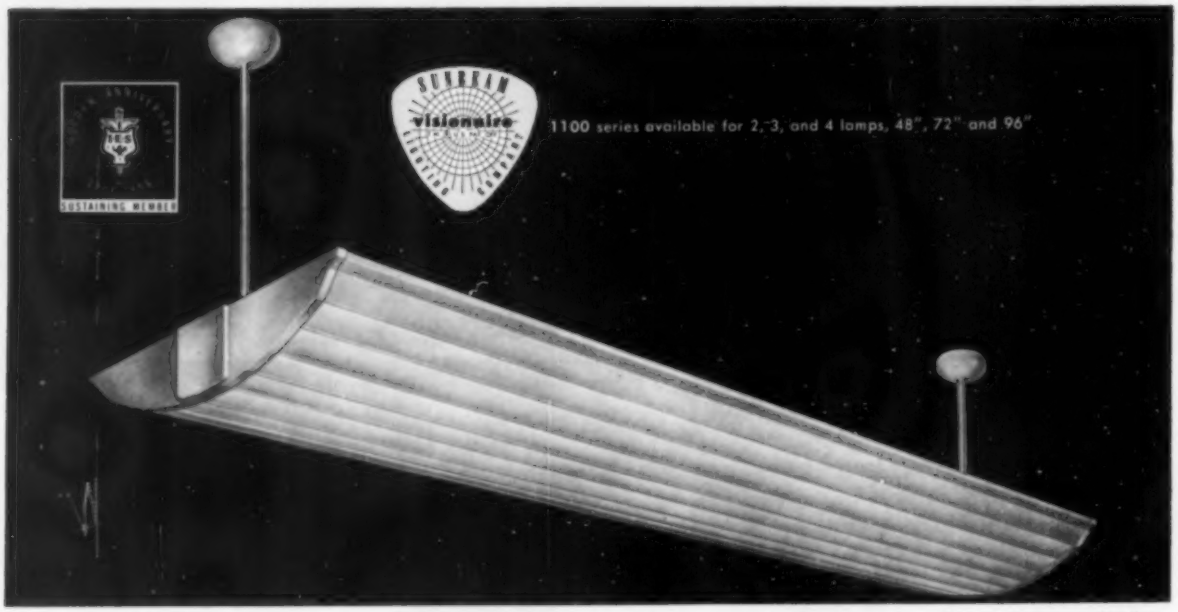
☐ Please send me The Perfeclite Data Sheet 56-C.
☐ Please send me the new Perfeclite Catalog 956.

Name.....
Address.....
City.....State.....

PERFECLITE PRODUCTS
THE MARK OF LIGHTING SERVICE

READ HOW EASY it is to perform difficult visual tasks with the new, totally indirect Sunbeam Lighting **1100** series. The unusually broad distribution of uniform, glareless, low brightness, high intensity illumination produced by this pendant Visionaire establishes new concepts of visual comfort. With its soft, eye-easy, luminous effect and clean-lined beauty, this **all-white** unit is perfectly designed for schoolrooms, offices, drafting rooms and other areas where the seeing task is critical.

Consider also the long-range savings available with this **all-metal,** low maintenance Visionaire. Parallel metal louvers allow circulating air currents to keep louver and lamp surfaces dust free. After mounting easy-to-handle fixture frame by **"hook-on"** method, the shielding cradle



hinges into place without tools for quick installation. The **1100** series relamps from the top without removing any part of fixture. Units available for use with higher lumen lamps, typical of today's trend. All metal parts are Bonderite-treated for lifetime corrosion resistance. Write for Bulletin 747 today.

Sunbeam Lighting Co., 777 E. 14th Pl., Los Angeles 21, Calif.

***UNUSUAL LOW-CEILING MERCURY VAPOR LIGHTING** in the work area of the Piantedosi Baking Co., Everett, Mass., is shown here. Even illumination of 85 foot-candles is maintained by 27 Sola-ballasted, color-corrected, 400-watt mercury vapor lamps at a 10' 6" mounting height. Holophane #635-AL fixtures were selected for brightness, deep shielding design, prismatic reflectors, up-lighting and convection air currents around the lamps. Electrical engineer is the Richard D. Kimball Company, Boston; installation by Kenworthy & Taylor, Inc., Everett, and distributor is Graybar, Boston.*

Constant-wattage mercury vapor transformers insure system performance and lumen output of low-ceiling, bake-shop lighting system

High lumen output, long lamp life, and relative ease of maintenance are being delivered by Piantedosi bakery's unusual, low-ceiling installation of mercury vapor lamps. Contributing to this superior performance are the Sola Constant Wattage Mercury Vapor Lamp Transformers from which this system operates.

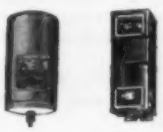
The famous constant-wattage operating principle of Sola transformers provides the following advantages:

- Low starting-current surge
- Regulated lamp wattage and light output
- Open-circuit protection
- Elimination of need for primary taps
- No lamp outages due to line voltage dips
- Extended lamp life

If you design, specify, or install mercury vapor lighting, indoors or outdoors, it will pay you to investigate the superior performance offered by Sola Constant Wattage Mercury Vapor Lamp Transformers. Your area representative, listed below, will be happy to provide information on your specific application.

For indoor applications, request Bulletin 3G-MV-211-A; For outdoor applications, request Bulletin 3G-MV-219 and 3G-MV-244

SOLA *Mercury Vapor Lamp* **TRANSFORMERS**



SOLA ELECTRIC CO.
4633 W. 16th Street
Chicago 50, Illinois

CONSTANT VOLTAGE TRANSFORMERS • LIGHTING TRANSFORMERS • CONSTANT VOLTAGE DC POWER SUPPLIES
SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • BRANCH OFFICES: Boston, Mass.; Cleveland, Ohio; Kansas City, Mo.; Los Angeles, Calif.; New York, N. Y.; Philadelphia, Pa.; San Francisco, Calif.; Wallingford, Conn. • *Representatives in Other Principal Cities*
Sola Electric (Canada) Ltd., Toronto 17, Ontario: 102 Laird Drive, Mayfair 4554

TRANSCENDING 10 YEARS OF LIGHTING PROGRESS!

NEW *radically improved*

MAINLINER LUMINAIRES

Exemplify every advancement made for ease and speed of application-installation and maintenance!

There is now a line of luminaires that incorporates *more improvements*—and permits *more optional variations* (in application sizes, shielding styles and mounting types) *than any other luminaires available before!* They are the *utterly* new, Mainliner Luminaires—created by Westinghouse!

These Mainliner Luminaires, for example, are designed precisely in 6 different multiples of exactly 12-inch modules. This is the modular planning declared *ideal*, by architects and designers, as *most* conducive to sound esthetic luminaire arrangement!—and *best* able to fulfill *virtually any interior lighting requirement.*

Mainliner shieldings include 13 different diffusers, lenses and louvers—each of *selected, most-appropriate* plastic, glass or steel!

Mainliner mountings are made by surface application, or in a *choice of 3 separate,* recessed-mounting types!

Mainliner housings have a *dimensional correctness,* exactly "mating" with any "squared" ceiling materials—are reinforced for much easier handling of so "shallow" a unit!—and are formed so that *no light escapes* around the door!

Doors open "either way". Flush, almost undiscernible latches have a positive, snap-action. All corners are mitered! And "Wrap-Around" wire-ways and "either-end" lead wires *simplify* installation!

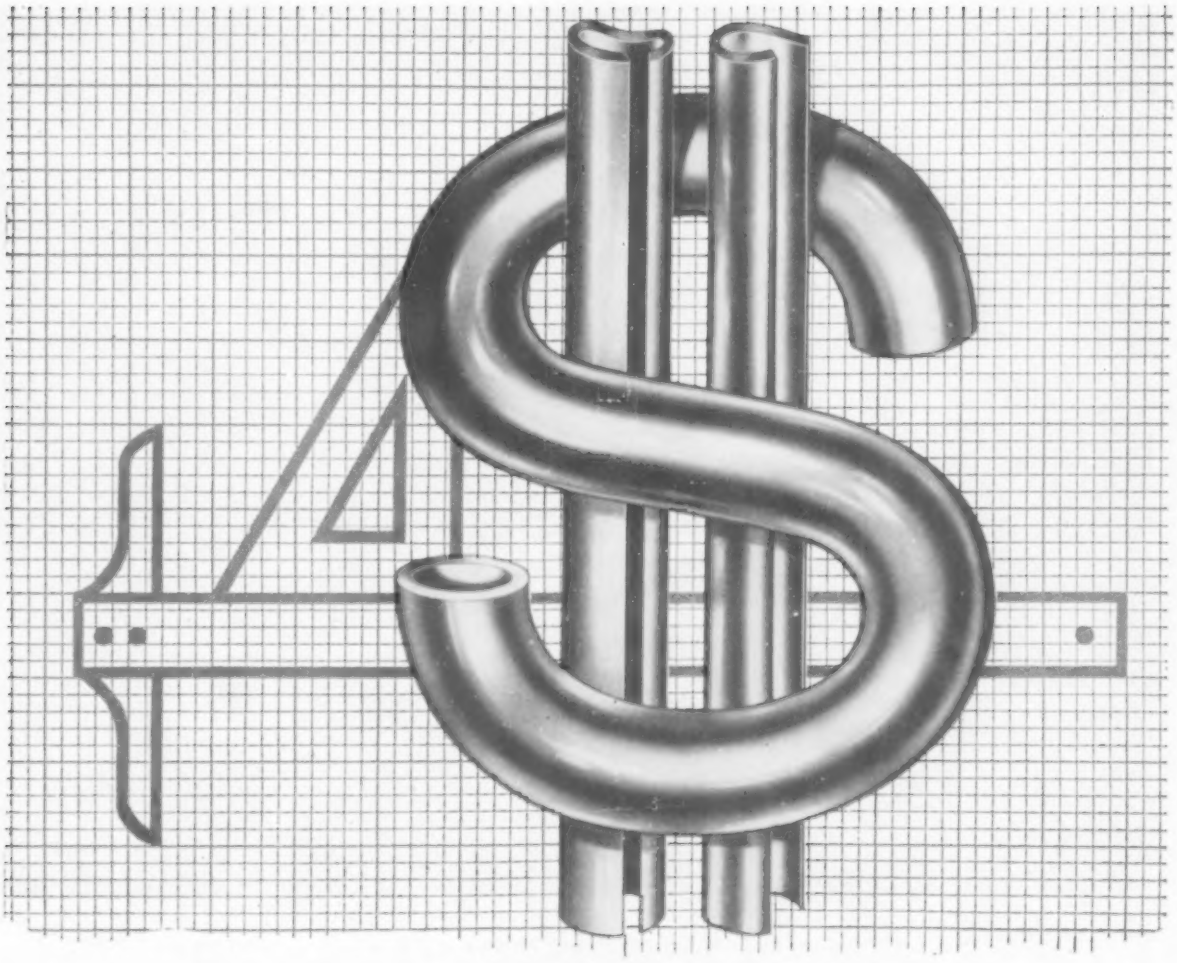
Mainliner Luminaires *already* are creating *new concepts* of *modern, decorative* lighting!—*new, vigorous ideation* for capable, leading lighting designers!

J-04416

Get your copy of this newest, full-color PLANNING GUIDE FOR LARGE AREA LIGHTING from your nearest Westinghouse representative. You'll *want* to employ Mainliner Luminaires *now!*

YOU CAN BE SURE...IF IT'S Westinghouse

Certified Lighting



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. . . helps put your product in profitable shape

WE EXTRUDE PROBLEMS INTO PROFIT-MAKERS

KSH engineers will work hand-in-hand with your designers . . . to demonstrate how high quality plastic extrusions can add extra sales appeal to your product.

You will learn that KSH extruded plastics improve the function and appearance of products . . . while substantially reducing production costs!

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600 FIXTURES INSTALLED IN 1 DAY

...proves **SMOOT-HOLMAN** Luminaires go up faster...easier

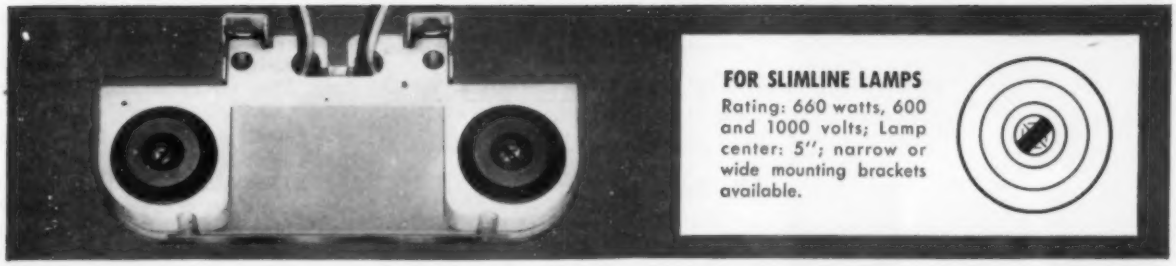
In a recent West Coast installation, 30 men installed 600 Smoot-Holman Industrial Luminaires in a single day. An amazing accomplishment, possible with the **unique design features** of Smoot-Holman fixtures. Faster installation and easier maintenance saves time and money. This economy comes from quality Smoot-Holman fixtures to benefit architect, contractor and customer.

For complete information on the rugged D-284 Industrial and other Smoot-Holman fixtures, call our nearest representative. Learn how you, too, can get more for your money from Smoot-Holman.

SMOOT-HOLMAN INGLEWOOD, CALIFORNIA

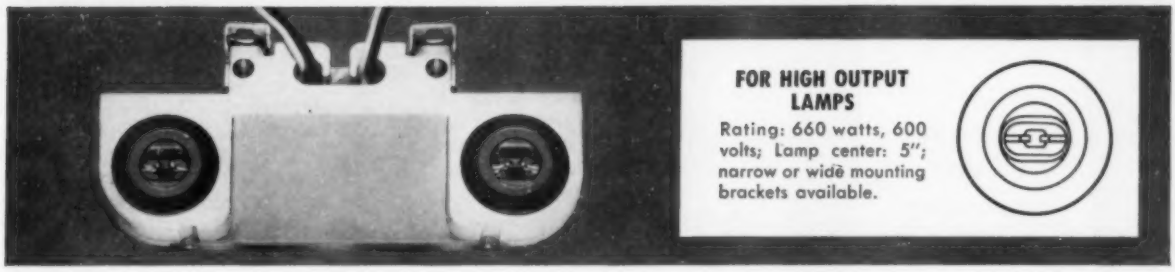
We support the National Lighting Bureau

service in the west and southwest for all school, commercial and industrial lighting



FOR SLIMLINE LAMPS
Rating: 660 watts, 600 and 1000 volts; Lamp center: 5"; narrow or wide mounting brackets available.

FOR BI-PIN LAMPS
Rating: 660 watts, 600 volts; Lamp center: 5"; narrow or wide mounting brackets available.



FOR HIGH OUTPUT LAMPS
Rating: 660 watts, 600 volts; Lamp center: 5"; narrow or wide mounting brackets available.

Revolutionary new design of turret* multiple lampholders with plastic bodies

GIVES IMPROVED PERFORMANCE AT LOWER COST

This new family of General Electric plastic turret* lampholders for rapid start bi-pin, slimline and high-output lamps offers many improvements in fixture and lampholder design.

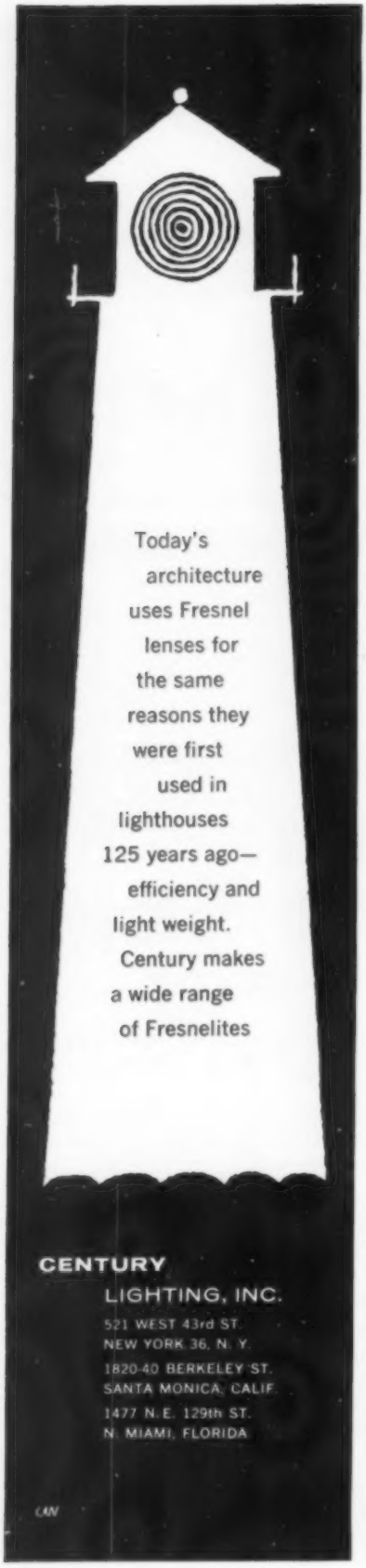
- ✔ Plastic turret body eliminates corrosion that may occur with metal bodies.
- ✔ New narrow brackets allow narrow channels to give the degree of up-lighting desired for many installations.
- ✔ New simplified socket mechanism provides easier, smoother lamp insertion.
- ✔ New slanted front cuts down the dark area between fixtures, and gives maximum light diffusion at the lamp ends.
- ✔ The leads from the sockets are kept separate through the use of individual lead-in holes for each set for easier wiring installation.
- ✔ All springs are made of stainless steel for maximum corrosion resistance.

These new plastic lampholders are also available with wide mounting brackets allowing interchangeability with old style lampholders. For complete information write: Accessory Equipment Department, General Electric Company, Bridgeport 2, Connecticut.

**Registered Trade-mark of General Electric Company*

Progress Is Our Most Important Product

GENERAL ELECTRIC


Today's architecture uses Fresnel lenses for the same reasons they were first used in lighthouses 125 years ago— efficiency and light weight. Century makes a wide range of Fresnelites
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N. MIAMI, FLORIDA
CAN

(*Continued from page* 30A)

IT SEEMS TO ME

A Dim View?

The opening statement of Mr. T. D. Wakefield's article "The Employee Takes a Dim View of Lighting," page 298 of the May I.E. is most correct. It was a shock to learn employees outside the lighting industry ranked lighting 42nd in a list of 58 benefits — at least until I reasoned with the problem a bit. Lighting, like the air they breathe, is only noticeable to those outside the industry when it affects their senses adversely. It is an entity taken for granted unless, like the proverbial well water, it just isn't there.

A Management, uneducated in lighting, might well deduce from the chart shown in the article, that spending money on good lighting is a waste because it won't make the employees any happier. But good lighting certainly, by the most radical stretch of the imagination, will not make them unhappy. And good lighting will pay for itself, not in immediate results, for it is a subtle thing, but over a long period of time in reduced worker fatigue and decreased accident rate.

Any one can see almost anything in his direct line of vision under footcandle levels from half a footcandle to 1000 ft-c. But those objects lying within the peripheral vision are not readily noticeable under poor lighting. And herein lies the hazard of a poorly lighted plant.

As a hypothetical example I present the simple but often very expensive and most frequent accident, the stumble and fall. A man walking down a poorly lighted aisle, looking where he is going, as he should, does not see a protruding dark colored skid against a dark colored floor because the "corner of his eye" did not "catch" the hazard. Had the aisle been properly lighted, his peripheral vision would have taken care of him.

The extreme importance of peripheral vision is well known to traffic engineers. And in many states driving license applicants are given a peripheral vision test.

The average man in the cited situation is completely unaware of such things as peripheral vision. He knows why he stumbled and will give the excuse, "I didn't see it." But neither he nor management is aware of *why* he didn't see it, and they both chalk it up to carelessness or clumsiness. Management pays the bill without further thought to the matter except to issue stricter rules regarding the placement of skids. But stricter rules won't change human nature. Misplaced equipment is only one of many hazards that could be cited and which could be avoided through poor lighting.

Poor seeing conditions are an insidious thing. They are responsible for worker fatigue without giving the victims, the employee and management, the slightest clue to the real cause of their effect.

As an example, Joe is a tool and die maker. Management knows enough about lighting to realize he needs lots of light on his bench. Joe has been provided with 80 ft-c. But the material stock, tool and die racks, aisles and general surrounds are lighted to 5 ft-c. As Joe goes about his work, the irises of his eyes, by their natural mechanics, are continually adjusting to the change in the level of illumination. Surprisingly enough, the muscles get tired after 4 or 5 hours of this, and a complaint of tired eyes causes management to think Joe needs glasses. "It can't be the lighting — he's got plenty!"

The things good lighting will avoid are not readily discernible to the average man outside of the lighting industry. And therefore, since the effects of poor lighting are often attributed elsewhere, it can be readily understood why lighting ranks so low on the popularity poll. It's the industry's job to educate management in the advantages of good lighting not only because it's our moral responsibility but, from a practical standpoint, it's our "bread-and-butter." — C. K. CHAMPLIN, *Illuminating Engineer, The Edwin F. Guth Company, St. Louis 3, Missouri.*

NEW MEMBERS

At the meeting of the I.E.S. Council June 12, in New York City, the following were elected to membership. Names marked * are transfers from Associate Member Grade.

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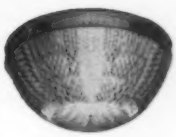
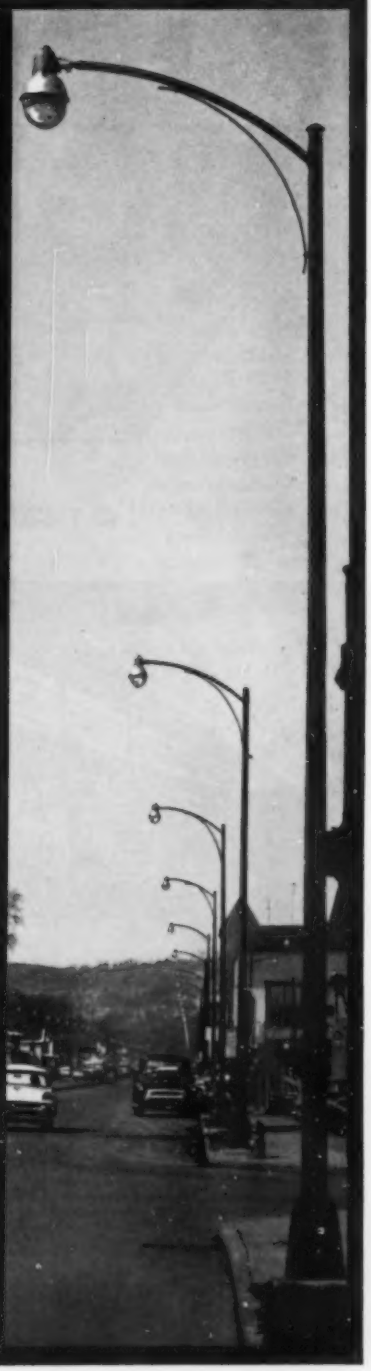


Line Material Spherolite Sr.

Revere Endoval



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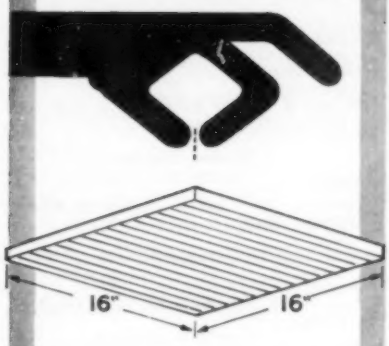

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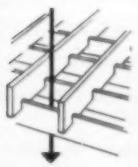

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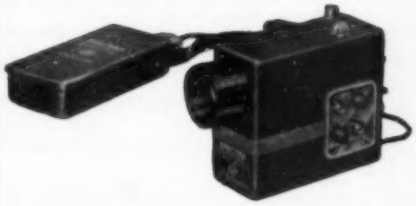

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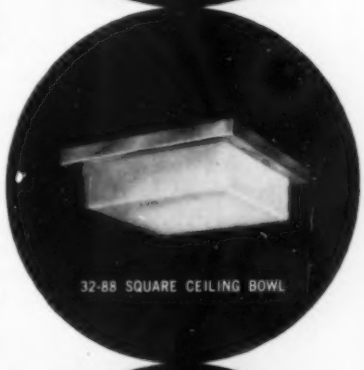

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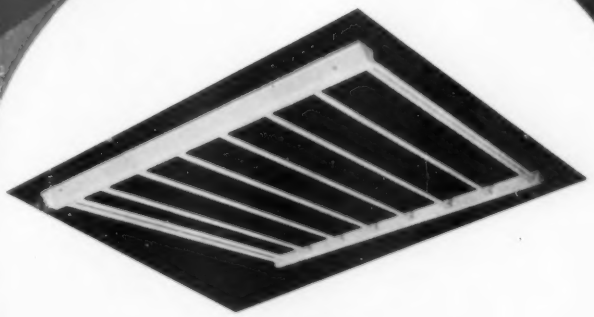
J. A. Wilson Lighting & Display Inc.	42A-43A

L&P Fluorescent Fixtures



THE LINE-LITE

Here's an attractive departure for lighting a store's merchandise to best effect. Achieves pleasing patterns, and excellent for area lighting. Best of all, the LINE-LITE is truly economical. Write for details.

In the Spotlight
FOR JULY

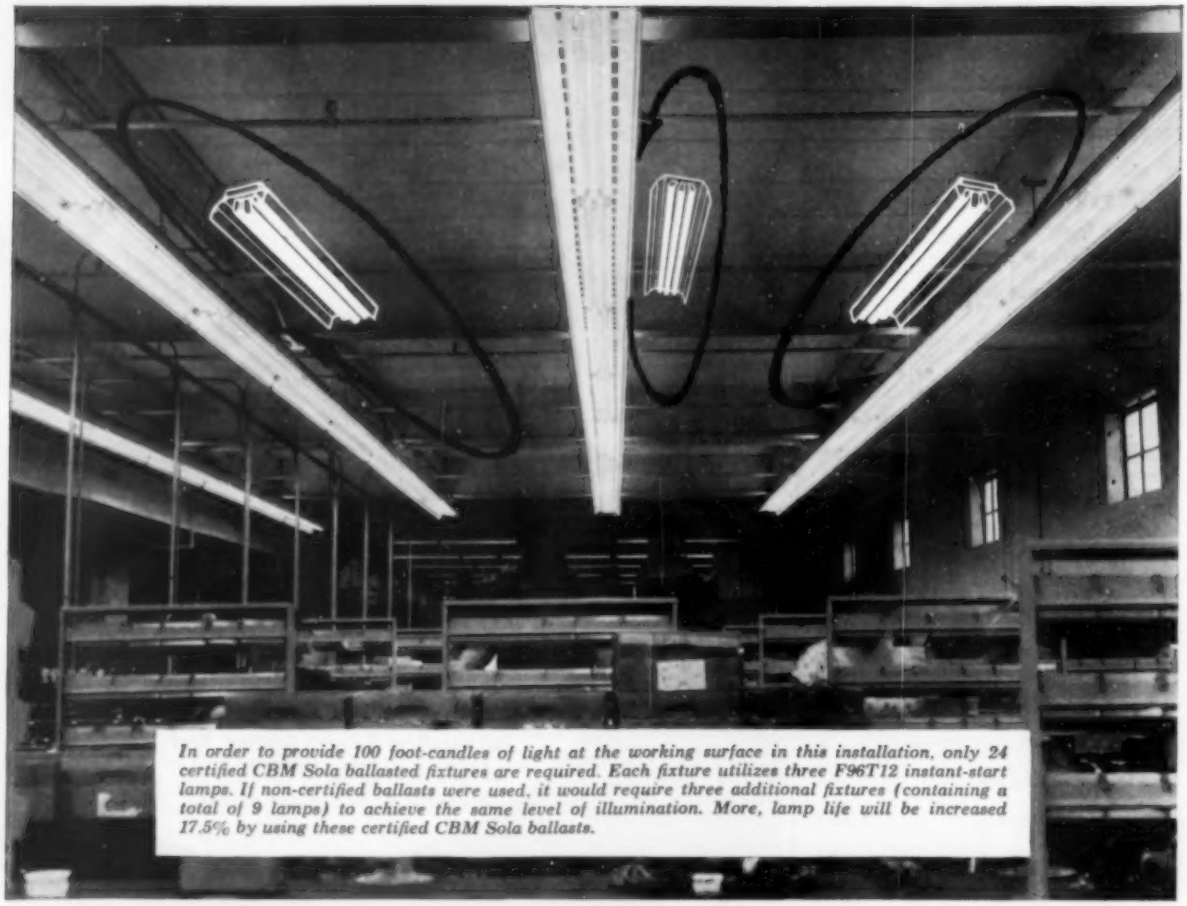
This L & P fixture is only one of Light & Power's complete line of fluorescent fixtures—with fine material, expert craftsmanship and quality control built into every unit. The result? Dependability, beauty and efficiency . . . every time!

LIGHT & POWER UTILITIES CORP.

Distributed by Electrical Wholesalers Only

Write or wire today for catalog and prices.

LIGHT & POWER UTILITIES CORP.
1035 Firestone Blvd., Memphis, Tenn.



In order to provide 100 foot-candles of light at the working surface in this installation, only 24 certified CBM Sola ballasted fixtures are required. Each fixture utilizes three F96T12 instant-start lamps. If non-certified ballasts were used, it would require three additional fixtures (containing a total of 9 lamps) to achieve the same level of illumination. More, lamp life will be increased 17.5% by using these certified CBM Sola ballasts.

How you can make 24 fixtures do the work of 27 . . . and extend lamp life 17.5%

To do its job efficiently and economically, a fluorescent lighting ballast *must* meet certain requirements for lamp life, light output, cool operation, reliable striking, and long ballast life. Minimum accepted standards for all of these factors have been set up by lamp manufacturers and *Certified Ballast Manufacturers*. Ballasts that meet or exceed these standards are called certified CBM ballasts, and carry a diamond shaped CBM emblem.

All Sola ballasts for general lighting applications are made to CBM specifications in every case where they exist, and are so certified. In addition, every Sola ballast carries the UL (Underwriters' Laboratories) emblem.

Many maufacturers are now making ballasts which carry *only* the UL emblem. *These ballasts are not designed to meet CBM specifications for minimum standards of performance.* Underwriters' Laboratories performs a valuable, but highly specialized function in testing ballasts. The UL emblem indicates *only* that safety requirements are met — UL does *not* test for operating characteristics that assure efficient, economical lamp performance and long lamp life.

Tests of these non-certified ballasts show that they reduce lamp life up to 28%; light output up to 13%, compared with certified CBM Sola ballasts used in the same installations. We invite you to send for an engineering report which shows what this means in operating costs. This report proves that although non-certified ballasts may sell for a *few cents less*, the operating costs of lighting systems incorporating them is *many dollars more* in terms of reduced lumen output and lamp life.

SOLA *Fluorescent* **BALLASTS**

Write today for your copy of this report on the real cost of non-certified fluorescent lighting ballasts.

SOLA ELECTRIC CO., 4633 W. 16th St., Chicago 50, Ill.

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SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • BRANCH OFFICES: Boston, Mass.; Cleveland, Ohio; Kansas City, Mo.; Los Angeles, Calif.; New York, N. Y.; Philadelphia, Pa.; San Francisco, Calif.; Wallingford, Conn. • Representatives in Other Principal Cities
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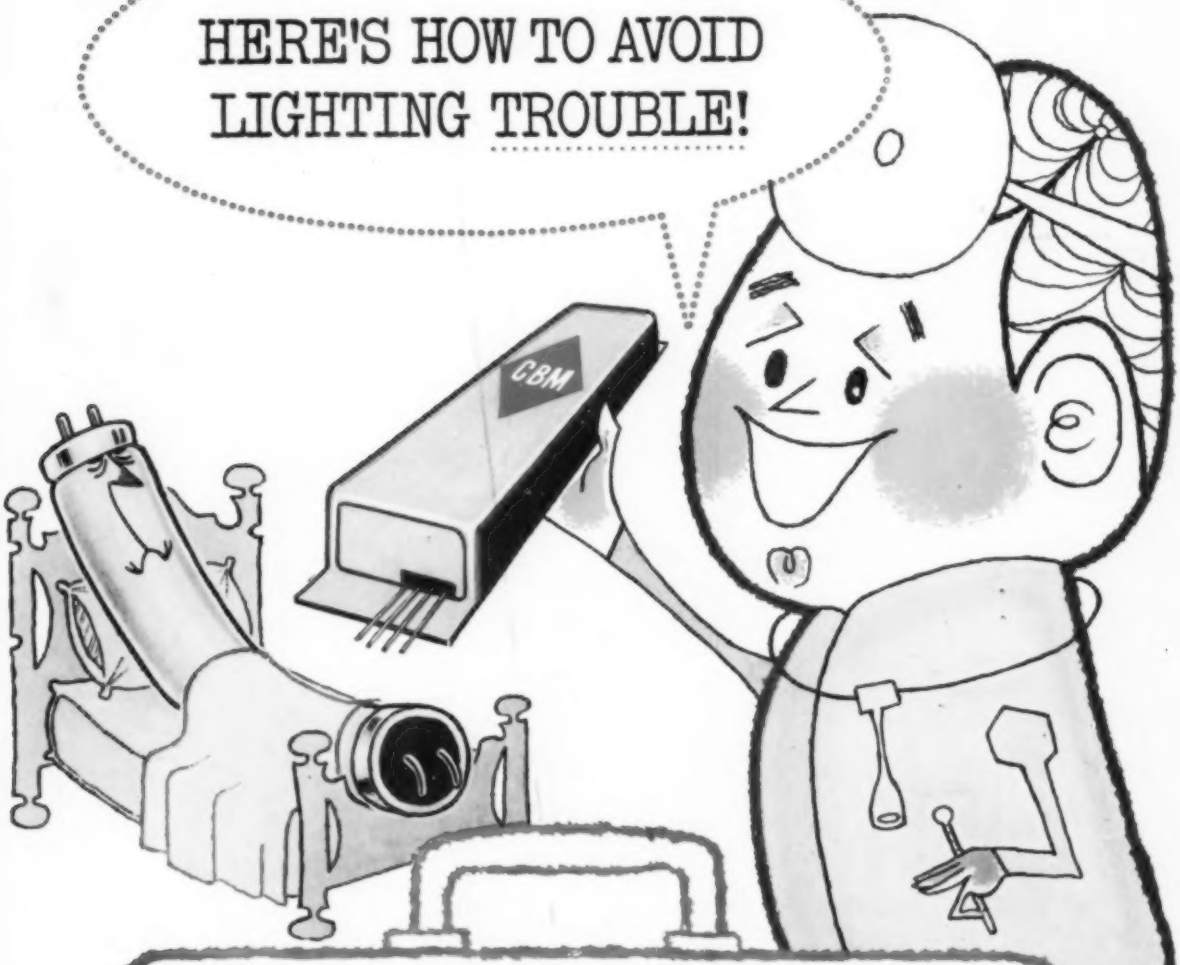
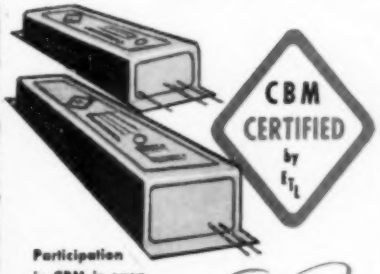
HERE'S HOW TO AVOID LIGHTING TROUBLE!



Poor ballasts can cost up to 30% loss in light output . . . shorter lamp life and shorter ballast life . . . so

Insist on CERTIFIED CBM *Ballasts in Fixtures*



Participation in CBM is open to any manufacturer who wishes to qualify.

You get optimum light output, rated lamp life and assured ballast life when fixtures use CERTIFIED CBM BALLASTS. That's the report of *all* the fluorescent lamp makers. You get High Power Factor and quiet operation, too.

For Certified Ballasts are made to exacting specifications "tailored to the tube" and checked by Electrical Testing Laboratories. And they're *all* U.L. approved. Assure top performance . . . insist on Certified Ballasts in fixtures.

Write for a copy of the new booklet that gives you the low down about approvals on ballasts.

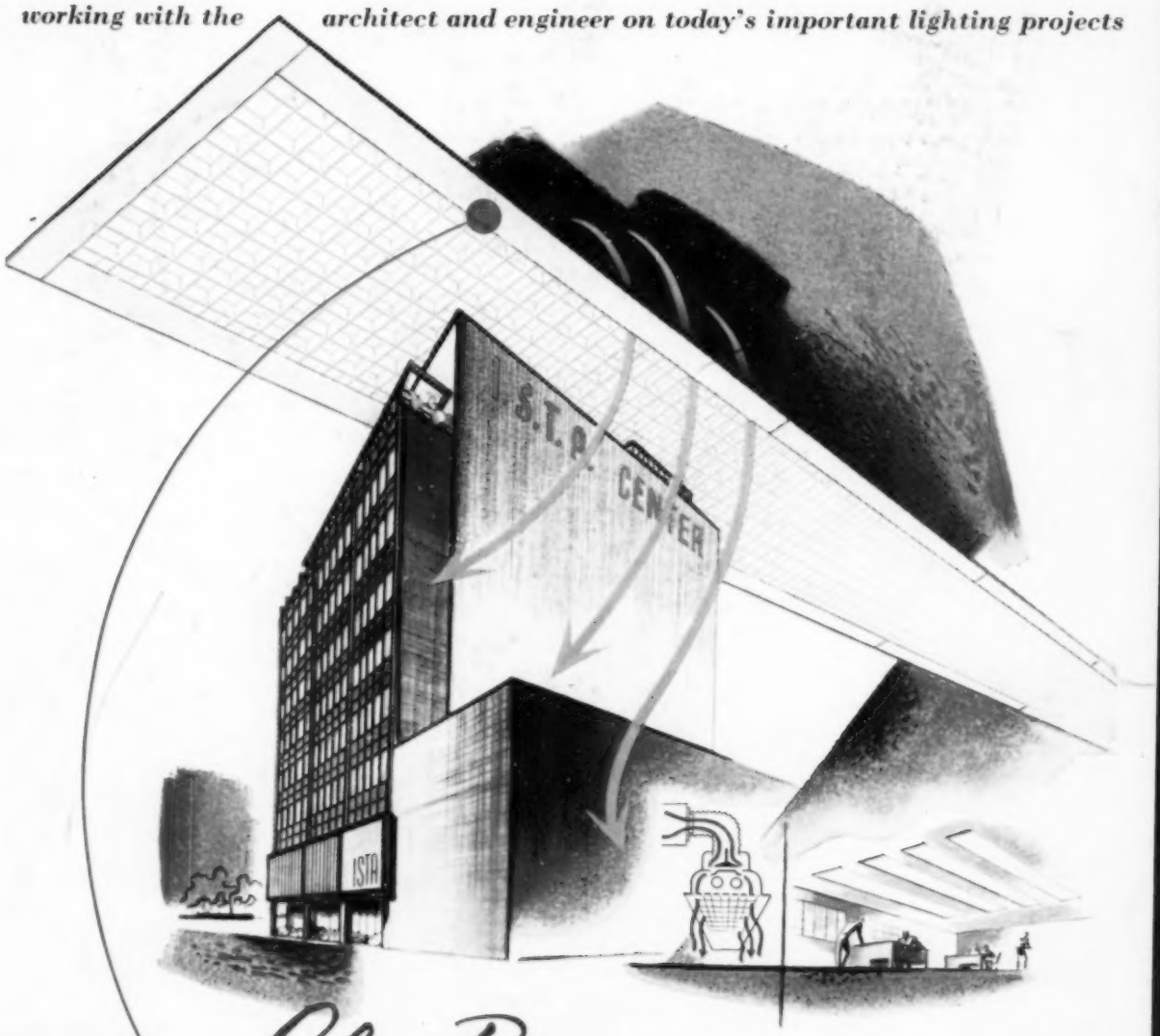
Seven leading manufacturers now make up

CERTIFIED BALLAST MANUFACTURERS

2116 KEITH BUILDING — CLEVELAND 15, OHIO

CBM 2-E

working with the *architect and engineer on today's important lighting projects*



1 mile of *Ceiling Beauty* doing double duty

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These new double-duty fixtures bring a new freedom to creative architecture. Gone is that discord of fixtures and air outlets! Instead: clean-lined, uncluttered ceiling beauty. Air outlets are engineered right into the lighting system! Result: greater economy, comfort and ceiling beauty. No double installation problems . . . improved draft-free air diffusion . . . modern, well-diffused, high efficiency Benjamin troffer lighting. Free illustrated brochure brings you the whole fascinating story of this new 2-in-1 fixture. Write: Benjamin Electric Mfg. Co., Dept. I, Des Plaines, Ill.

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...always the source of good lighting